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EFFECT OF SULFADRUGS AND ANTIBIOTICS ON THE VERNALIZATION OF CERTAIN INDIAN CROP PLANTS*

By

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[Received on 28th May 1959]

INTRODUCTION

That sulfadrugs and antibiotics have a profound effect on growth of plants is now an established fact. Retardation of growth in higher plants by the former group of chemicals has been reported by several workers (Grace, 1938; Audus and Quastel, 1948 and Bharadwaj and Rao, 1954, 1955a). A promotive effect has been recorded by Grace (1938) by using sulfanilamide solution in lower concentration on tomato cuttings and certain seeds and also by Bharadwaj and Rao (1955b) through presowing soaking of wheat seeds with 10 ppm. of cibazol and sulfaguanidine.

As regards antibiotics, their effect at the concentration of 50 ppm. and higher have in almost all the cases been of an inhibitory nature (Ventura, 1952). Nickell (1949) while working with virus tumours of *Rumex acetosa* L. recorded stimulation of growth of this tissue at certain low levels of both penicillin and streptomycin. In his further studies, Nickell (1953) recorded that germinating seeds of agave were stimulated in their growth by certain concentrations of thiolutin. An accelaration of seedling growth of several plants treated with low concentrations of diamine, procaine penicillin, bacitracin and terramycin was also noted by him.

*This investigation was carried out at Government Hamidia College, Bhopal.

Pre-vernalization treatment of seeds with certain growth substances has been found to alter the nature of response in several plants (Ghosard and Poignant, 1951; Chakravarti, 1954; Chakravarti and Pillai, 1955; and Kojima *et al*, 1957). As sulfadrugs and antibiotics modifies growth of plants and thus in this respect behave in a way similar to the growth substances it was thought desirable to determine their effect on vernalization in the present investigation.

MATERIAL AND METHODS

The following sulfadrugs and antibiotics obtained from the local druggists have been tried :

Cibazol, elkosine, irgafen, sulfadiazine, sulfaguanidine, sulfamezathine, sulfanilamide, sulfapyridine, sulfathalidine, achromycin, aureomycin, chloromycetin, dehydrostreptomycin, erythromycin, procaine penicillin and terramycin. Concentrations of sulfadrugs used have been 5,000, 1,000, 100 and 10 ppm. and of antibiotics, 100, 10 and 1 ppm. in distilled water. Seeds of *Brassica campestris* L., T. 10 S. 13, *Lens esculanta* Moench, variety Ample, *Linum usitatissimum* L., T. N. P. 9 and *Cicer arietinum* L., T. 87 were subjected to pre-and post-vernalization soaking in Petridishes (partial immersion) in the above solutions and water for 8 hours at 30°C. Seeds sown immediately after treatment with the different chemicals referred above acted as controls.

For pre-vernalization treatment, the seeds after soaking were allowed to sprout and those doing so within a reasonable time were sorted out and transferred to the refrigerator for vernalization. All the seeds were chilled for three weeks which usually brings about a complete vernalization in *Brassica* and *Linum* and partial ones in the rest. Post-vernalization treatments were carried on *Brassica* seeds chilled for three weeks and on the rest for 35 days.

Records were kept of the time taken for the opening of the first flower on a plant in *Lens* and *Cicer*, of the number of leaves developed prior to the appearance of the flower buds in *Brassica* and of both in *Linum*.

EXPERIMENTAL RESULTS AND DISCUSSION

General effects : Almost all the sulfadrugs inhibited germination of *Brassica* seeds at the highest concentration. In *Linum* this effect has been seen event at 1,000 ppm. in certain cases, which might be due to the retention of the chemicals in the mucilage present on the seed coat.

A pink colour developed on the cotyledons of *Brassica* seedlings raised from seeds treated with streptomycin and aureomycin 100 ppm., the latter being more effective than the former. Chloromycetin, erythromycin and terramycin at the highest concentration brought about partial or complete bleaching of the cotyledonary leaves in *Brassica* without affecting the chlorophyll content of the subsequent ones. In *Lens*, complete bleaching upto the 5th leaf was noted in certain plants as a result of treatment with 100 ppm. of terramycin. Gram failed to germinate at the highest concentration of the three antibiotics referred above, whose lower concentrations did not affect the chlorophyll content of the cotyledonary leaves. No signs of bleaching could be seen in *Linum* in any of the antibiotic treatment.

Vernalized and normal seed treatment : Soaking of vernalized and normal seeds in the solutions of sulfadrugs and antibiotics brought about statistically significant

increase in the vegetative cycle of gram in the highest concentrations of elkosine, cibazol, sulfanilamide and sulfaguanidine, which varied from 3 to 10 days in vernalized plants and 6 to 14 days in the non-varnalized ones over their corresponding controls. A delay in ear emergence in wheat by 30 days with irgafen and 38 days with sulfamezathine has been recorded by Bharadwaj and Rao (1954).

In vernalized *Lens*, a delay in flowering was noticed in 5,000 ppm. of sulfanilamide and in 100 ppm. of achromycin, while that in *Linum* in 100 and 10 ppm. of erythromycin. No effect, however, could be seen in the treatment of normal seeds.

Treatment with sulfadrugs and antibiotics failed to bring about any change in the leaf number of *Brassica*-both vernalized and normal.

Pre-vernalization treatment : Prevernalization treatment brought about a statistically significant delay in flowering is several cases in *Lens* and *Linum*. Data for these are presented in table I. There was no effect on the node number in *Brassica*

TABLE I

Effect of sulfadrugs and antibiotics on the vernalization of *Lens* and *Linum* Number of plants are given within brackets. Sown on Oct. 22, 1957.

Chemical	Conc. in ppm.	*Lens*		*Linum*				
		Time taken for anthesis in days	Delay over water vernalized	Time taken for anthesis in days	Delay over water vernalized	Leaf No.		Increase over wate vernalized
Cibaol	5,000	98·0 (5)	13·5	—	—	—		—
do	1,000	—	—	43·1 (6)	6·3	—		—
Elkosine	1,000	92·7 (10)	8·2	—	—	—		—
Irgafen	5,000	101·0 (8)	16·5	—	—	—		—
do	1,000	94·1 (8)	9·6	—	—	—		—
S-diazine	1,000	100·8 (5)	16·3	—	—	—		—
do	100	90·6 (15)	6·1	52·4 (11)	15·6	77·7	(11)	22·3
do	10	92·0 (8)	7 5	42·1 (11)	5·3	63·7	(11)	8·3
S-guanidine	1,000	—	—	42·3 (10)	5·5	64·9	(10)	9·5
S-mezathine	5,000	91·4 (9)	6·9	—	—	—		—
do	1,000	93·5 (8)	9·0	41·9 (10)	5·1	64·0	(10)	8·6
do	100	—	—	—	—	60·0	(12)	4·6
do	10	—	—	41·5 (11)	4·7	66·4	(11)	11·0
S-nilamide	1,000	104·0 (6)	19·5	51·5 (4)	14·7	77·5	(8)	22·1
do	100	98·5 (12)	14·0	45·5 (10)	8·7	79 6	(8)	24·2
do	10	—	—	41·9 (9)	5·1	71·1	(9)	15·7
Achromycin	100	93·8 (10)	9·3	46·5 (8)	9·7	87·0	(8)	31·6
do	10	90·7 (6)	6·2	43·2 (10)	6·4	66·5	(10)	11·1
Dihydrostreptomycin	100	100·4 (5)	15·9	49·2 (5)	12·4	98·2	(5)	42·8
do	10	93·5 (12)	9·0	46·7 (10)	9·9	89·2	(10)	33·8
Water vernalized		84 5 (8)	—	36·8 (10)	—	55·4	(10)	—
Unvernalized control		102·0 (7)	17·5	72·9 (10)	26·1	135·5	(8)	80·1

while the only increase in vegetative cycle in *Cicer* was found in plants raised from 100 and 10 ppm. of sulfadiazine.

A reference to table I will reveal that several of the sulfadrugs bring about various degrees of nullification of the vernalization effect in *Lens* and *Linum* which is almost complete in the former treated with cibazol, irgafen, sulfadiazine and sulfanilamide in the highest concentration. It would rather be interesting to record that vernalized seedlings of *Lens* treated with these sulfadrugs had extremely stunted radicles. A shortening of the roots after sulfadrug treatment has been recorded by several workers (Grace, 1938; Woods, 1940; Audus and Quastel, 1948 and Bharadwaj and Rao, 1954).

Of the antibiotics, only dihydrostreptomycin and achromycin had inhibitory effect on the flowering of vernalized *Lens* and *Linum*, which does not seen to be due to the presence of plant harmones in the commercial preparations of the antibiotics (Nickell, 1953) as out of seven of them used in the present study only two are found to act on *Linum* in a way similar to the hormones (Chakravarti, 1954).

In view of the unsatisfactory nature of our knowledge (Nickell, 1955) regarding mechanism of action of sulfadrugs and antibiotics on the metabolism of plants it would be rather too premature to conclude that inhibitory action of some of them recorded in the course of the present investigation has a direct bearing on the mechanism of vernalization.

SUMMARY

In the present investigation, the effect of 9 sulfadrugs and 7 antibiotics obtained from the local druggists has been studied on the process of vernalization of *Brassica campestris* L., *Lens esculanta* Moench, *Linum usitatissimum* L. and *Cicer arietinum* L.

Destruction of chlorophyll in the cotyledonary leaves of *Brassica* has been found in treatments with chloromycetin, erythromycin and terramycin and in several leaves of *Lens* with terramycin.

Sulfadrugs have inhibitory action on the process of flowering of *Cicer*. Various degrees of nullification of the low temperature effect in *Lens* and *Linum* have taken place as a result of prevernalization treatment with cibazol, irgafen, sulfadiazine, sulfanilamide, achromycin and dehydrostreptomycin.

In view of the unsatisfactory nature of our knowledge of the action of these chemicals on plant metabolism it is rather difficult to decide the bearing of the above observations on the mechanism of vernalization.

LITERATURE CITED

Audus, L. J. and Quastel, J. H., (1948). *Ann. Bot. N. S.*, 12 : 27.

Bharadwaj, S. N. and Rao, I. M., (1954). *Curr. Sci.*, 23 : 290.

———————, (1955a). *Sci. and Cult.*, 20 : 600.

———————, (1955b). *Agra Univ. Jour. Res. (Sci.)*, 4 : 387.

Chakravarti, S. C., (1954). *Nature*, 174 : 461.

Chakravarti, S. C. and Pillai, V. N. K., (1955). *Phyton*, 5 : 1.

Chouard, P. and Poignant, P., (1951). *C. r. Acad. Sci. Paris*, 232 : 103.

Grace, N. H., (1938). *Canad. J. Res.* (Sec. C), 16 : 143.

Kojima, H., Yahiro, M. and Eto, T., (1951). *Jour. Fac. Agri. Kyushu Univ.* 2 : 25.

Nickell, L. G., (1949). Doctoral Diss. Yale Univ.

———, (1953). *Antibiotics and Chemotherapy*, 3 : 449.

———, (1955). Antimetabolites and Cancer, Amer Assoc. for the Advancement of Sci. pp. 129-151.

Provasoli, L., Hutner, S. H., and Pintner, I. J., (1951). Cold Spring Harbor Symp. Quant. Biol., 16 : 113.

Ventura, M., (1952). Ceara School of Agron. (Fortaleza, Brazil) Tech. Publ. 38.

Von Euler, H., (1947). Kem. Arb. II, 9 : 1.

Woods, D. D., (1940). *Brit. J. Exptl. Path.* 21 : 74

SEASONAL CYCLE IN THE SPERMARY OF *HILSA ILISHA* (HAMILTON)

By

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[Received on 18th March 1954]

INTRODUCTION

Considerable work on various cytological problems of spermatogenesis of fishes has been done, but the literature on the morphological and histological changes correlated with seasonal fluctuations in piscine testes is limited. Some valuable work in this direction has been done in Europe, America and Japan, but in India this interesting problem of fish biology has received negligible attention.

Hilsa ilisha is one of the most important food fishes of India and is available at Allahabad throughout the year. The cyclic changes in the testes of *Hilsa ilisha* have, therefore, been studied to work out some valuable data concerning the breeding habits of this fish. Histological studies reveal that the spawning cycle corresponds to the periodical cell production in the testes of *Hilsa ilisha*.

HISTORICAL SURVEY

Extensive historical reviews have been written by James (1946), and Ghosh and Kar (1952) so the author does not propose to deal with it in detail except giving the important references. The pioneer workers on the seasonal cycle in the spermary of fishes are Turner (1919, 1937), Geiser (1922) Foley (1926), Hann (1927 and 1930), Kulaev (1927), Vaupel Jean (1929), Craig-Bennet (1931), Bennington (1936), Mathews (1938), Bullough (1939), Jones (1940), Fredrick (1941), Weisel (1943) and James (1946).

Recently Cooper (1952) made histological study of the testes of crappies *Pomoxis nigromaculatus* and *Pomoxis annularis*. Ghosh and Kar (1952) observed that there is no seasonal variation in the testes of *Heteropneustes fossilis* and the spermatogenesis continues throughout the year. Yamamoto (1953) worked on flounder *Liopsetta obscura* with a view to clarify the seasonal cycle in the spermary of marine fishes.

MATERIAL AND METHODS

The Indian shad *Hilsa ilisha* for the present study were collected from the rivers Ganga and Jamuna covering a radius of about forty miles around Allahabad. The investigations were carried on for more than two years, thus, covering the entire twelve-month period. Collections were regularly made twice a week. The data collected here are based on the examination of 418 males. Fishes were caught alive and weighed afresh on the spot, the total length and weight of each fish being

recorded. While still alive the specimens were dissected for gonadal examinations. The testes of each fish were weighed to the nearest miligram before fixation. Small pieces of testes were fixed in Bouin's fluid and in Allen's modification of Bouin's fluid. Both of these fixatives gave satisfactory results but the latter however proved to be definitely superior. After embedding in paraffin the blocks were sectioned at 6 to 8 microns in thickness and stained with Delafield's haematoxylin and counterstained with eosin which gave rather excellent results. Man's methylblue-eosin, Mellory's triple and Heidenhain's iron alum haematoxylin were also used.

CORRELATION OF THE GONAD-WEIGHT AND THE FISH WEIGHT

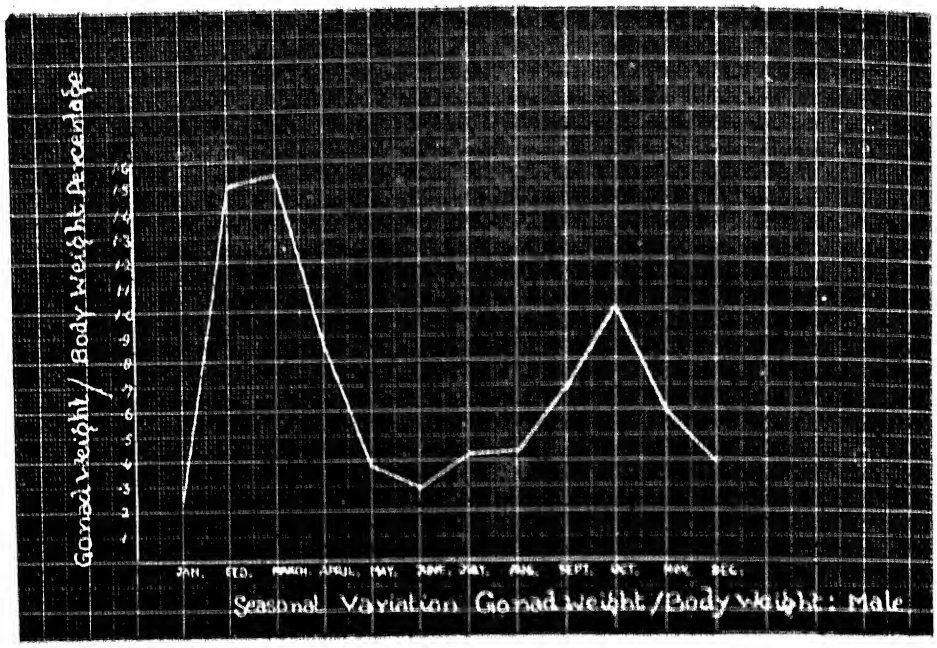
The workers studying the seasonal variations in the spermary of fishes consider the percentage ratio of the testes-weight to the body weight a fairly constant and reliable criterian for such studies (James 1946, Mathews 1938). The author has also studied this relationship and the results have been illustrated in graph 1. Table 1 shows the average weight of 418 male Hilsa with corresponding average weights of the testes.

A perusal of the graph 1 will show that the ratio of the gonad-weight to the body-weight reaches its peak twice a year (in October and March) and thereafter declines rapidly in November and April respectively.

TABLE 1

Average weights of male *Hilsa ilisha* taken in monthly collections from the Ganga and Jamuna, at Allahabad, with corresponding average weights of testes. Calculated testes weight and body weight ratio expressed as percentage of body weights.

Months	No. of specimen taken	Average weight of the fish	Average weight of testes	Avereage ratio between testes and body weight
		grams	grams	percent
January ...	29	514·94	1·19	0·23
February ...	29	423·53	6·35	1·5
March ...	59	387·59	6·0	7·55
April ...	54	362·55	3·16	0·87
May ...	41	401·02	1·50	0·38
June ...	46	289·95	·85	0·29
July ...	18	415·27	1·75	0·42
August ...	30	469·47	2·0	0·43
September ...	24	516·69	3·54	0·69
October ...	22	536·32	5·41	1·01
November ...	45	436·63	2·62	0·6
December ...	21	473·93	1·83	0·39



GRAPH I

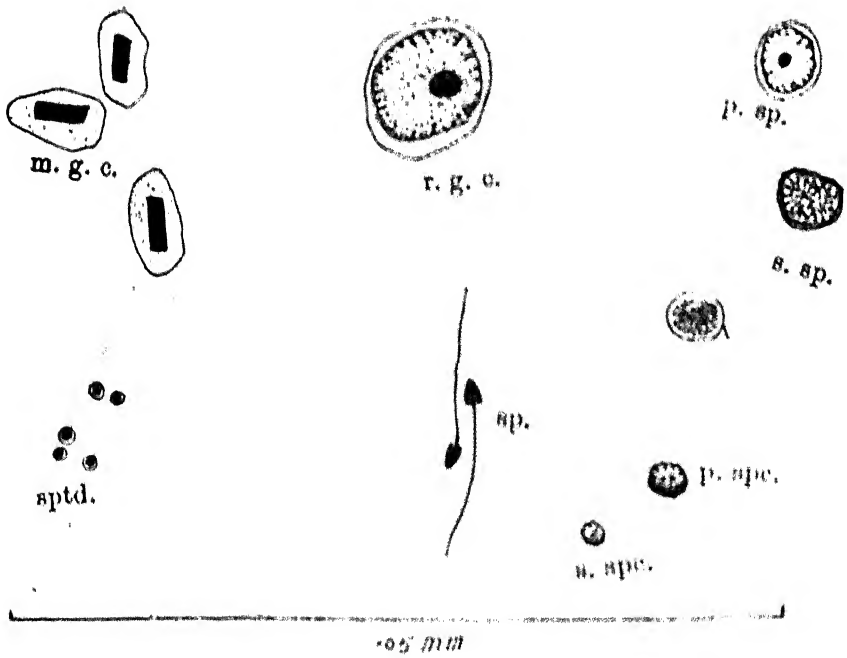


Fig. 1. Camera lucida diagrams of the different types of cells in the spermatogenesis of *Hilsa ilisha*.

The testes are paired bodies situated dorsal to the gut and ventral to the air bladder. They remain free from each other along the whole length. A short duct, originates from posterior end of each testis, joins the corresponding duct from the opposite side and finally opens to the exterior through the median urinogenital aperture. The testes are for the most part asymmetrical.

The following stages of testes have been found at the collection :—

1st Stage :—Slender thread-like testes which cannot be distinguished from ovaries in immature condition.

2nd & 3rd stages :—Poorly developed testes pink in colour occupying one-third to half the length of the body cavity.

4th Stage :—Enlarged and opaque testes occupying about more than half the length of the body cavity. They are of almond colour.

5th Stage :—Testes become more enlarged than those at the 4th stage and occupy a length of about three-fourths of the body cavity. They are packed with milt and appear milky white in colour.

6th Stage :—This condition differs from the 5th stage only in having ducts full of sperms, oozing to the exterior on slight pressure.

7th Stage (Spent condition) :—They are pink ribbon like testes occupying one third of the length of the body cavity. They resemble the testes during early stages of development except in the condition of their ducts which are still full of spermatozoa.

HISTOLOGY

The testes are divided internally into numerous interseptal spaces or lobules by means of complex net-work of thin connective septa (fig. 3). These septa join the outer wall of the testes giving it strength against internal pressure. In the interseptal spaces, along the margins of the inter-lobular septa, there are found irregular chains of cyst-like structures in the lumen of the lobules. Each cyst behaves as a separate unit in the maturation process and has cells in more or less in the same stage of maturity but various stages occur in different cysts. The ripe cysts break at a certain stage of maturity liberating their contents and thereby enlarging the lumen of the lobules. In *Hilsa ilisha* the cysts break at the secondary spermatocyte stage.

The following types of cells have been observed in the spermatogenesis of *Hilsa*.

Migrating germ cells (Figs. 1 & 5) :

They are capsule-like cells with distinct rectangular dark stained nuclei. Their cell walls are poorly defined and the cytoplasm takes light eosin stain. They are found in large numbers and exhibit linear migration through inter-lobular tissue. The migrating cells either infilterate into the inter-lobular spaces or get encysted in the interseptal tissue where a new lobule is in the making. They are of common occurrence when the testicular activity is at a high level.

Resting germ cells (Figs. 1 and 4) :

These germinal cells are large in size, each with a large nucleus. The chromatin in their nuclei are seen forming thin fibrils which join the single nucleolus to the periphery. The cytoplasmic area is very thin. They are seen either lying quiscent along the inter-lobular walls or embedded in them. They are frequently seen in testes between 1st-3rd stages of maturity or in spent testes undergoing reconstruction and passing through the same stages of maturity. They give rise to primary spermatogonia.

Primary spermatogonia (Figs. 1 and 5) :

The change from the resting germ cell to the spermatogonium does not involve the structure of the cell ; only the size and affinity for stains are affected. Both the chromatin and the ground substance of the nucleus develope more affinity for stains. The cytoplasm shrinks and, on the whole, these cells are smaller than the resting germ cells.

Secondary Spermatogonia (Fig. 1) :

The secondary spermatogonia are smaller than primary spermatogonia and have darkly stained nuclei with distinct nuclear wall. The chromatin of their nuclei are arranged in irregular threads with knobs here and there. There are no nucleoli. They are present in the testes of 4th and 5th stages of maturity.

Primary spermatocyte (Figs. 1, 6 & 8) :

They are much smaller in size than the secondary spermatogonia. The chromatin has a tendency to concentrate at one side of the nucleus. The cytoplasm is seen as a pellicle round the nuclear membrane and is smaller in proportion than what is found in spermatogonia. They are found in testes at 4th, 5th and 6th stages of maturity.

Secondary spermatocyte (Figs. 1 & 8) :

The secondary spermatocytes differ from the primary spermatocytes in only being smaller in size. They are liberated into the testicular lobules where they undergo the later stages of spermatogenesis.

Spermatid (Figs. 1 and 8) :

Spermatids are spherical structures much smaller than secondary spermatocytes. The nuclear material is condensed to form a homogenous dark stained mass. The cytoplasmic area is very thin and the cell wall is inconspicuous.

Within the lobules of ripening testes are seen certain bodies which are bigger than the spermatids but have similar staining affinity. They are comparable to the 'spermatid masses' of Hann (1927). They are formed of a group of spermatids with their nuclei remaining distinct and cell walls fusing together at the periphery and dissolving internally. Big homogenous aggregations of these 'spermatid masses' are of common occurrence in *Hilsa ilisha* (Fig. 7).

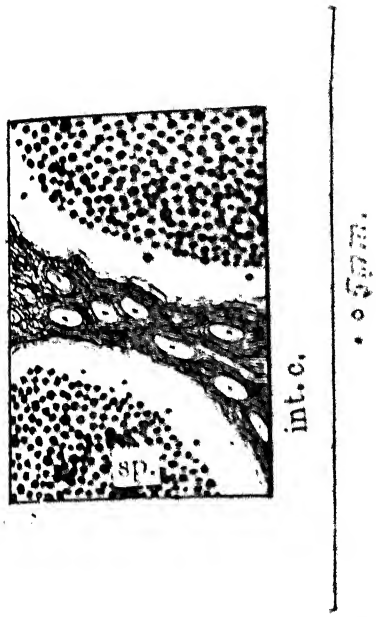


Fig. 2. Camera lucida diagram of the T. S. of testis of *Hilsa alosa* showing the interstitial cells embedded in an inter lobular wall. Int. c.-Interstitial cell ; sp-Spermatozoa.

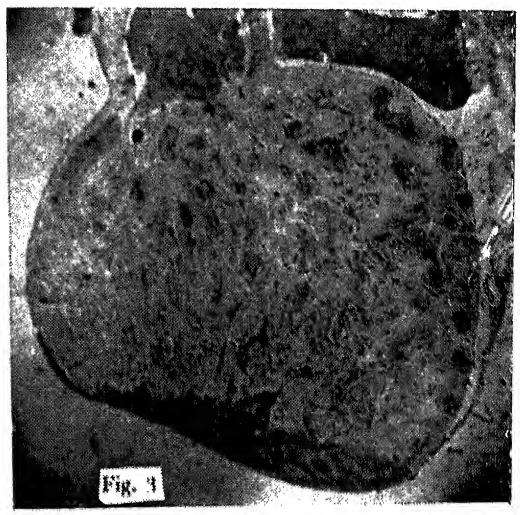


Fig. 3. Photomicrograph of the T. S. of a partially spent testis showing empty lobules.

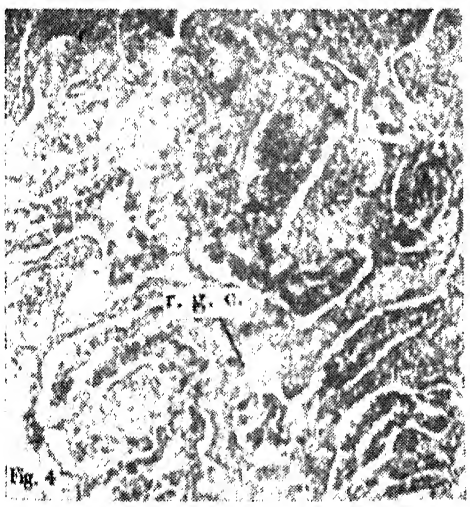


Fig. 4. Photomicrograph of the T. S. of a spent testis. Interlobular walls have collapsed. Only early stages of spermatogenesis are seen (oil immersion).

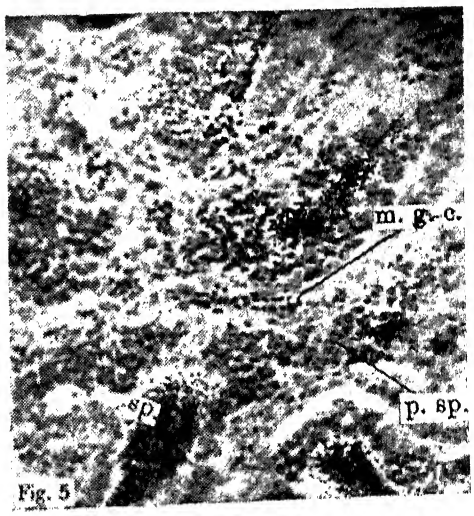


Fig. 5. Photomicrograph of the T. S. of spent testis showing migrating germ cells. (High power).

Fig. 6. Photomicrograph of the T. S. of testis, showing spermatid masses, primary spermatocyte and sperms (High power).

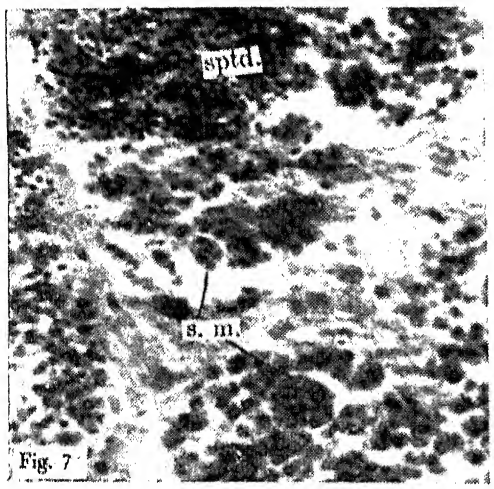


Fig. 7. Photomicrograph of the T. S. of testis showing spermatid masses (oil immersion).

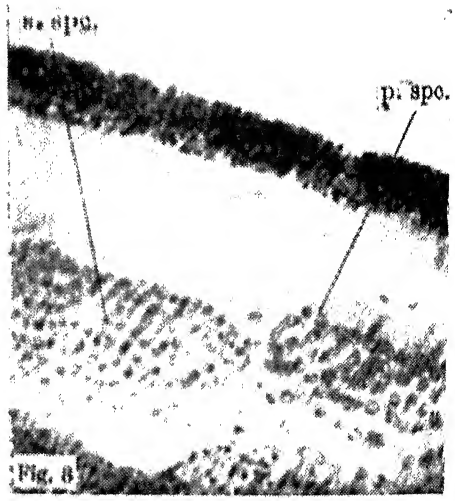


Fig. 8. Photomicrograph of the T. S. of a testis showing primary and secondary spermatocytes (oil immersion).

Sperm :

The mature spermatozoon has a spear-shaped head with a tail arising from a notch in it (Fig. 1). The head of the sperm takes deep blue stain. It differs from the spermatid in having greater affinity for stain and in possessing a tail (Fig. 1).

Interstitial cells :

Embedded in the narrow septa of the lobules are seen cells of irregular shape with indistinct cell membrane. Their response towards stain is very poor and they take red eosin stain; the darkness depending on the concentration of the cytoplasm. They are not of common occurrence but whenever they have been observed the testes bearing them have shown very advanced stages of maturity. They are glandular in appearance.

Seasonal variations :

For the sake of convenience in describing the testicular cycle, keeping in view the histological and morphological variations, the year has been divided into the following periods :—

December and January—

The testes are in spent condition due to the previous spawning season. The inter-lobular spaces in the spent testes have been reduced to mere crevice-like spaces due to the collapse of the inter lobular walls on account of the loss of spermatozoa. The migrating germ cells, resting germ cells and spermatogonia are of common occurrence. The latter two types of germ cells are seen both embedded in as well as lying along the walls of the lobules (Fig. 3). The curve illustrating testes weight/body weight relationship also strikes at a very low percentage during this period, thereby showing close relationship between the variations in the stages of maturity and the corresponding changes in the production of the different stages of spermatogenesis.

February—

In early February the condition of testes is similar to that of January but as the month passes on the reconstruction activities are visible and distinct lobules with resting germ cells and primary spermatogonia develope. The migrating germ cells are also seen embedded in the inter-lobular walls. By the middle of the month the lobules are seen dilated with their inter-lobular walls stretched and all the stages of spermatogenesis including finished sperms are visible. Thus we find that in this month the testes rapidly pass through 4th, 5th and 6th stages of maturity. 'Spermatid masses' are also seen in some of the preparations.

March—

The testes are in fifth and sixth stages of maturity and the lobules are seen packed with spermatozoa. The inter-lobular walls are in tension and have become very thin. Along the sides of these separating walls are seen chains of cysts of

different stages of spermatogensis. Resting germ cells are rare and migrating germ cells are not seen at all. Besides the encysted spermatogenic stages secondary spermatocytes and spermatids are also seen in the lumen of the lobules. This indicates that there is a regular and continuous supply of germ cells during breeding season. Partially spent testes with empty lobules peripheral in position are also seen.

April—

The lobules are not seen packed with sperms and the inter lobular walls show a gradual release in their tension. The lobules towards the periphery show more empty spaces than those situated at the centre. The sperm ducts are still full of sperms. During this period both, spent and partially spent testes are found, the frequency of former being greater than the latter.

May and June—

The testes are in spent condition undergoing reconstruction. The degree of reconstruction is subject to the individual variation in the spawning period of the fish.

July and August—

The testes show advanced stages of spermatogenesis including finished sperms. The lobules are enlarged and the inter-lobular septa are seen in a state of tension. The testes are mostly in fifth stage of maturity. Some individuals that have acquired 6th stages of maturity start spawning.

September and October—

Majority of specimens have their testes full of sperms. The inter-lobular walls are in great tension and the lobuules are packed with sperms. There is always seen a continuous formation of cysts of germinal cells of different stages of spermatogenesis. The activity of testes is at the peak during this period — a condition corresponding to that of March. 'Spermatid masses', are of common occurrence.

November—

The testes are in a condition similar to that found in April.

DISCUSSION

The study of gonad-weight ; body weight ratio reveals that the testes of *Hilsa ilisha* reach their maximum weight twice a year *i.e.*, in October and March and thereafter decline rapidly. This shows that there are two breeding seasons in *Hilsa* viz., autumn and spring. The histological studies are in conformity with this conclusion.

Chacko and Ganapati (1949) working on the bionomics of *Hilsa ilisha* from the river Godavari, commented on the asymmetry between the two lobes of the

testes whereas Pillay (1954) reported that the testes are symmetrical in specimens from the river Hoogly. The author agrees with Chacko and Ganapati in his observations that *Hilsa* caught in the local waters (Ganga and Jamuna) show asymmetry in the testes lobes.

The histology of testes show the existence of a complex net-work of connective tissue septa dividing them into a number of lobules. These septa join the outer wall of the testes to give them strength against internal pressure. A similar discription has been given by Turner (1919), Mathews (1938) and Cooper (1952).

Along the sides of these inter-lobular walls of the testes of *Hilsa ilisha* are seen irregular chains of cysts of various stages of spermatogenesis and a particular cyst possesses cells at the same stage of spermatogenesis—a condition reported from a number of other teleosts e.g., sunfish (Turner 1919); *Cottus bairdii* (Hann 1927), *Lebistes reticulatus* (Jean Vaupel 1929), Fundulus (Mathews 1938), Salmon (Weisel 1943) and Crappies (Cooper 1952). These cysts break at a certain stage of maturity liberating their contents in the lumen of the lobules. In the material under study the cysts break at the secondary spermatocyte stage as in crappies (Cooper 1952).

The migrating germ cells with rectanguluar nuclei and poorly defined cell walls are comparable to the migrating germ cells described by Jones (1940). These cells give rise to resting germ cells. The various stages of transformation are clearly visible. The resting cells on the other hand correspond to the primary germ cells of minnow (Bullough 1932) and the resting spermatogonia of *Onchorynchus nerka* (Weisel 1943) and *Lebistis reticulatus* (Jean Vaupel 1929). They are numerous in the testes at early stages of spermatogenesis and gradually decrease as the maturity approaches. In fully matured testes though they are fewer in number yet are seen to persist.

The author agrees with Turner (1919), Hann (1927), Bullough (1939) Jones (1940) and Cooper (1952) that there is a gradual decrease in the size of the spermatogenic cells with the progressive growth in their stages of maturity.

The spermatogonial cells which give rise to secondary spermatogonia are observed lying along the inter-lobular septa as well as encysted in connective tissue of the septa. They are present in the testes of Hilsa at all stages of maturity. The secondary spermatogonia have greater affinity for stain. The chromatin of their nuclei are arranged in irregular threads with knobs here and there on them. They are seen encysted along the inter-lobular walls. They give rise to primary spermatocytes.

The nuclei of primary spermatocytes exhibit synizesis with their chromatin collected to one side as reported by Hann (1927), Craig-Bennet (1931), Bullough (1939) and Jones (1940).

The secondry spermatocytes differ from the primary spermatocytes in being smaller. Hann (1929) and Bullough (1939) have reported that they are of very short existence and as such are not observed frequently. In *Hilsa ilisha* the author has never encountered any such difficulty. They have been observed frequently and at this stage the cysts rupture liberating the secondary spermatocytes into the lobules.

The spermatids are smaller than the secondary spermatocytes with homogeneous dark stained compact nuclei and inconspicuous poorly defined cell wall as described by Jean Vaupel (1929), Weisel (1943) and Cooper (1952). Hann (1927)

reported the occurrence of 'spermatid masses' in cottus bairdii. Again in 1930 the same author working on the variations in the spermatogenesis in the family cottidae asserts that 'spermatid masses' occur only in the members of the family cottidae. It is interesting to note that beyond the expections of Hann these structures have been observed by the author in *Hilsa ilisha* which is not a member of the family cottidae. The functions of 'spermatid masses' are still obscure.

Hilsa ilisha do not have a single spawning act is evident from the occurrence of partially spent testes during the spawning seasons. Completely spent testes are found only at the end of the spawning seasons. Moreover there is a regular and continuous supply of germ cells during the breeding seasons which is indicated by the presence of all the stages of spermatogenesis in the breeding seasons. The above mentioned facts led the author to infer that the fish have multi-spawning instead of a single spawning act.

ACKNOWLEDGEMENTS

The author is grateful to the late Professor D. R. Bhattacharya for suggesting this problem and to Dr. S. K. Dutta for his guidance. He is also thankful to the Council of Scientific and Industrial Research, India for the financial aid.

SUMMARY

(1) The testes of *Hilsa ilisha* exhibit seasonal variation.

(2) Allahabad *Hilsha* has two breeding seasons—(*a*) August to November and (*b*) February to March with the peak spawning periods in October and March.

(3) The testes are divided into a number of lobules by strands of connective tissue. Along these inter-lobular walls are seen chains of cysts of various stages of spermatogenesis. A particular cyst has cells of the same stage of spermatogenesis. At the secondary spermatocyte stage the cysts break liberating their contents into the lobules.

(4) There is a gradual decrease in the size of the spermatogenic cells with the progressive growth in their stages of maturity.

(5) 'Spermatid masses' thought to be characteristic feature of the family Cottidae only are seen to occur in *Hilsa ilisha* also.

(6) *Hilsa* do not have a single spawning act.

REFERENCES

Bennington, N. L. (1936). Germ cell origin and spermatogenesis in the Siamese fighting fish, *Betta splendens J. Morph.*, 60, 103-125.

Bullough, W. S. (1939). A study of the reproductive cycle of the minnow in relation to the environment. *Proc. Zool. Soc. London*, 109, 79-102.

Chacko, P. I. and Ganapati, S. V. (1949). On the bionomics of *Hilsa ilisha* (Ham.) in the Godavari river. *Madras University J.*, Vol. 18, pp. 116-122, Madras, India.

Cooper, L. J., (1952). A histological study of the reproductive organs of Crappies (Pomoxis nigromaculatus and Pomoxis annularis) *Trans. Amer. Micro. Soc.*, 71, 393-404.

Craig-Bennet, A. (1931). The reproductive cycle of three-spined stickleback, *Gasterosteus aculeatus. Linn. Philos. Trans.*, B219, 197-297.

Foley, J G. (1926) The spermatogenesis of Umbra limi, with special reference to the behaviour of the spermatogonial chromosomes in the first maturation division. *Biol. Bull*, 50, 117-140.

Fredrick, J. N. (1941). Seasonal histological changes in the testis of the sea cat, *Galeichthys felis*. *Anat. Rec.* 18 (Suppl.), 27.

Geiser, S. W. (1922). Seasonal changes in the testis of *Gambusia affinis*, the top minnow. *Anat. Rec.* 23, 104-105.

Ghosh, A. and Kar, A. B. (1952). Seasonal changes in the gonads of the common Indian Cat fish *Heteropneustes fossilis* (Bloch.) *Proc. Zool. Soc. Bengal*, 5, 29-50.

Hann, H. W. (1927). The history of the germ cells of *Cottus bairdii*. *J. Morph.*, 43, 427-497.

———————— (1930). Variations in spermatogenesis in the teleost family Cottidae-*Jour. Morph. and Physiol.*, V. 50, No. 2, pp. 393-411.

James, M. F. (1946). Histology of gonadal changes in the, blue gill, *Lepomis macrochirus* (Rafinesque) and large mouth bass, *Huro salmoides* (Lacepede). *J. Morph.*, 79, 63-91.

Jones, J. W. (1940). Histological changes in the testis in the sexual cycle of male salmon parr (*Salmo salar* L. Juv.) *Proc. Roy. Soc., London*, B, 128, 499-509.

Kulaev, S. (1927). Beobachtungen uber die Veranderungen der Hoden des Flussbarches (Perca fluvia tilis L.) im Laufe des jahres. *Rev. Zool. Russe* 7, Vol. 3, pp. 50-53.

Mathews, S. A. (1938). The seasonal cycle in the gonads of Fundelus, *Biol. Bull.*, 75, 92-95.

Oordt, G. J. Van. (1925). *Proc. Acad. Sci.* 26, 440-474 (Quoted by Hann.)

Pillay, T. V. R. (1954). Contributions to the studay of certain estuarine fishes. Ph. D. Thesis, University of Travancore.

Turner, C. L. (1919). The seasonal cycle in the spermary of the perch. *J. Morph.*, 32, 681-711.

———————— (1937). Reproductive cycle and superfoetation in poecilid fishes. *Biol. Bull.* 72, 145-164.

Vaupel, Jean, (1929). The spermatogenesis of Lebistes reticulatus. *Jour. Morph. and Physiol.*, V. 47, No. 2, 555-585.

Weisel, G. F. (1943). A histological study of the testes of the *Onochorhynchus nerka* *J. Morph.* 73, 207-230.

Yamamoto, K. (1953). Seasonal cycle in the spermary of the flounder *Diopsetta obsura*. *Bull. Hokkaido Regional Research Laboratory*, No. 8, pp. 52-62.

ON *MEHRASTOMUM MINUTUM* N. G., N. SP. (TREMATODA : DIGENEA) FROM THE INTESTINE OF WHITE NECKED STORK, *DISSOURA EPISCOPA EPISCOPA*.

By

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[Received on 24th November 1958]

INTRODUCTION

The present communication deals with the description of a new form of digenetic trematode collected from the intestine of white necked stork, *Dissoura episcopa episcopa* shot near Raipur in the month of December, 1956. The work was carried out in the Department of Zoology, College of Science, Raipur.

Mehrastomum minutum n. g., n. sp.

Description :

In the living condition the parasites were flesh coloured. The worms are elleptical with slight constriction at the level of the acetabulum behind which the body becomes more broad and pointed at the posterior end. The body measures 2·09 – 2·85 mm. in length and 0·85 – 1·13 mm. in breadth at the level of the ovary. The anterior end has a rudimentary collar measuring 0·22 – 0·31 × 0·36 – 0·48 mm. The entire body and the collar are devoid of spines.

The oral sucker is subterminal, oval and measures 0·28 – 0·32 × 0·21 – 0·29 mm. The ventral sucker is much more larger than the oral sucker and lies at a distance of 0·7 – 1·12 mm. from the anterior end. It measures 0·39 – 0·45 × 0·42 – 0·49 mm. The prepharynx is very small and leads into a well developed pharynx which is 0·17 – 0·21 mm. long and 0·19 – 0·22 mm. broad. The oesophagus is 0·15 – 0·32 mm. long and 0·07 – 0·098 mm. broad. It has wavy margins. The intestinal bifurcation lies at a distance of 0·35 – 0·87 mm. from the anterior end. The intestinal caeca extend upto the posterior end of the body. The caeca are not crenated.

The excretory pore lies at the posterior end of the body. The excretory bladder is peculiar in structure as it represents five saccular chambers placed one above the other. The chambered stem of the bladder extends upto the level of the testes. The anterior most chamber gives rise to the main arms one on either side that extend upto the anterior end of the body where they take a turn and run posteriorly to end at the posterior end.

The gonads lie in the posterior half of the body. The testes are intracaecal, diagonally situated one behind the other. They are roughly triangular, transversely elongated and lobulated. The lobulations are more clearly marked towards the posterior face than towards the anterior face of the testes. The anterior testis is

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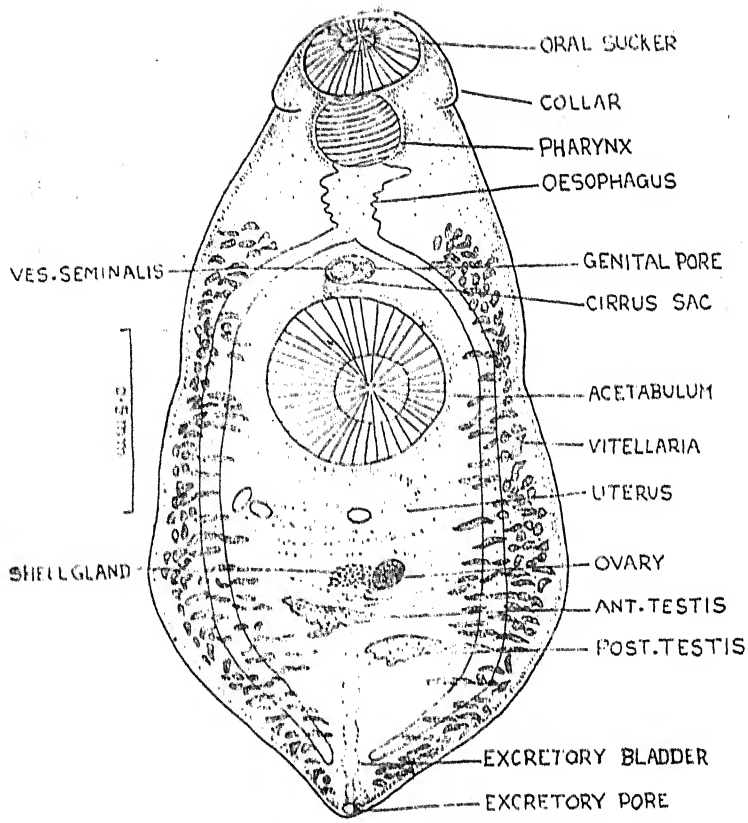


Text Figure 1. *Mehrastomum minutum* n. g., n. sp. dorsal view.

situated at a distance of 1·46 – 2·17 mm. from the anterior end and measures 0·14 – 0·28 mm. in length and 0·06 – 0·08 mm. in breadth. It lies slightly towards the left of the median line. The posterior testis is 0·11 – 0·18 × 0·07 – 0·098 mm. in size and is situated towards the right side of the median line. The distance between the two testes is 0·07 – 0·09 mm. The cirrus sac is oval, lying in the median line between the intestinal bifurcation and the acetabulum. It measures 0·105 × 0·054 mm. and contains an oval vesicula seminalis, a tubular pars prostatica and a muscular cirrus. The vesicula seminalis measures 0·054 × 0·036 mm. The genital pore is situated in the median line midway between the intestinal bifurcation and the acetabulum.

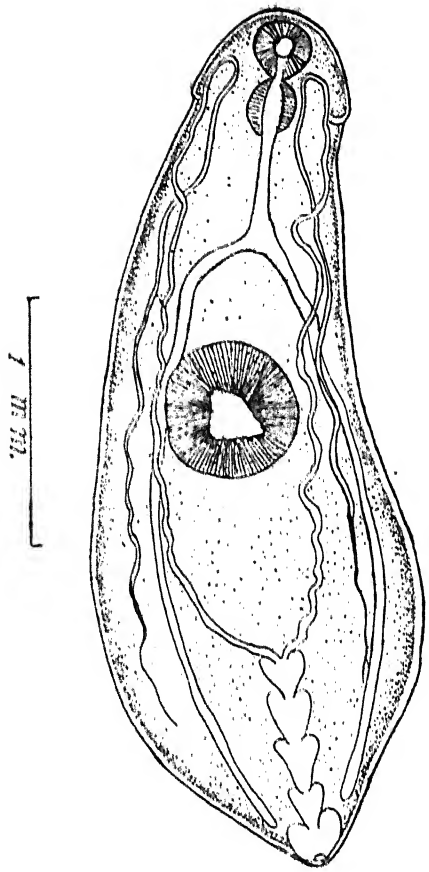
The ovary is oval in shape and lies at a distance of 1·32 – 1·95 mm. from the anterior end. It is pretesticular, slightly to the right of the median line and has a size of 0·07 – 0·99 × 0·06 – 0·099 mm. The oviduct arises from the posterolateral margin of the ovary and ends in the ootype which is located towards the left side of the ovary. The vitelline glands consist of small elongated follicles which extend from the level of the intestinal bifurcation to the posterior end of the body. The follicles generally occupy the extracaecal margin above the acetabulum but behind the acetabulum they are caecal and intercaecal. The transverse vitelline ducts meet each other infront of the anterior testis in the median line to form a small yolk reservoir from where a small median vitelline duct meets the ootype. The uterus emerges from the posterior face of the ootype and takes a round of the ovary on the right side. It undergoes two intercaecal transverse coils before opening at the genital pore. A receptaculum seminis is absent. The uterine eggs are few in number, usually 3 – 9, embryonated and measure 0·066 – 0·105 × 0·036 – 0·057 mm.

DISCUSSION

The above description of *Mehrastomum minutum* n. g., n. sp. conforms to the revised characters of the family Philophthalmidae in general, in which Yamaguti (1958) includes five subfamilies: Philophthalminae Looss, 1899; Echinostephallinae Yamaguti, 1958; Parorchiinae Yamaguti, 1958 (emended Parorchinae Lal, 1936); Skrjabinovermiinae Yamaguti, 1958 and Cloacitrematinae Yamaguti, 1958. However, the distribution of vitellaria from the intestinal bifurcation to the posterior end of the body in the present form necessitates the elaboration of this character in the family Philophthalmidae for its inclusion. The possession of a poorly developed collar without spines, saccular nature of the excretory bladder and the distribution of the vitellaria prominently mark out this species from all the known genera and subfamilies under the family Philophthalmidae. A new subfamily Mehrastominae is, therefore, created for the reception of *Mehrastomum minutum* n. g., n. sp.

Mehrastominae n. subfam.

Subfamily diagnosis—Philophthalmidae: body elliptical, slightly constricted in the acetabular zone. Head with rudimentary collar without spines. Acetabulam large in the middle third of the body. Pharynx well developed. Oesophagus with wavy outline. Intestinal caeca simple, reaching posterior end of body. Testes diagonal, in posterior half of body. Cirrus sac above acetabulum. Genital pore median or submedian. Ovary pretesticular. Vitellaria lateral, continuous from intestinal bifurcation to posterior end. Uterus between testes and acetabulum. Excretory bladder Y shaped with the stem divided into chambers. Parasitic in the intestine of birds.



Text Figure 2. *Mehrastomum minutum* n. g., n. sp. excretory system.

Mehrastomum n. g.

Generic diagnosis—Philophthalmidae, Mehrastommae : body elliptical slightly swollen at the level of gonads, aspinose. Collar poorly developed without spines. Prepharynx and orsophagus present. Pharynx well developed. Acetabulum larger than the oral sucker lying in the middle third of body. Testes two diagonal transversely elongated. Cirrus sac entirely above acetabulum. Genital pore preace tabular, median near intestinal bifurcation. Ovary oval, pretesticular. Vitellaria-fullicles small, extending from intestinal bifurcation to the posterior end. Uterus between testes and acetabulum. Uterine eggs large, few in number operculate. Excretory bladder Y shaped, stem divided into five saccular chambers. Parasitic in the intestine of birds.

Genotype—*Mehrastomum minutum* n. g., n. sp.

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The author is grateful to Dr. R. N. Singh, Head of the Zoology Department, College of Science, Raipur for his valuable suggestions and guidance in this work. The author also acknowledges the help rendered by Shri Ishwari Prashad Tiwari, Lecturer in Zoology during the preparation of this paper. Thanks are also due to Dr. Karam Singh, Principal, College of Science, Raipur for providing the research facilities in the Department.

REFERENCES

Dawes, B. 1956. The Trematoda. Cambridge University Press.

Lal, M. B. 1936. A new species of the genus *Parorchis* from *Intanus hirpelensis* with certain remarks on the familly Echinostomidae. *Proc. Ind. Acad. Sci.* 4 (1), 25-35.

Yamaguti, S. 1958. Systema Helminthum, Vol. I. The Digenetic Trematodes of Vertebrates Part I and II. Interscience Publishers, INC, New York.

REPORT ON A CESTODE, *HYMENOLEPIS FARCIMINOSA* (GOEZE, 1782), COLLECTED FROM *ACRIDOTHERES TRISTIS* (L. 1766) OF DELHI STATE, TOGETHER WITH THE OBSERVATIONS ON ITS TESTICULAR PATTERNS

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[Received on 7th January 1959]

The material forming the basis of this paper is obtained from the bird, *Acridotheres tristis* (L. 1766) shot in the suburbs of Delhi.

All measurements, unless otherwise stated, are given in millimeters.

Family HYMENOLEPIDIDAE Fuhrmann, 1907.

Sub-family Hymenolepidinae Perrier, 1897.

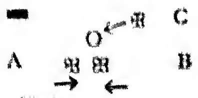
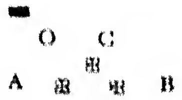
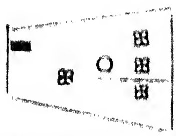
Hymenolepis Weinland, 1858.

H. farciminosa (Goeze, 1782)

The earliest record of this species in India is given by Southwell (1922) from *Corvus macrorhynchus* of Zoological Gardens, Calcutta. It was later added by Meggitt (1926) from *Acridotheres tristis* and *A. albocinctus* of Rangoon while Burma was a Province under British India. The collection of the present material, besides the addition of useful morphological details, serves an important and interesting study in testicular variations as indicated in Table 1. It is noteworthy to mention that the occurrance of the present material forms the first record from Delhi State.

The worms attain the maximum length of 115·0 and a breadth of 1·50. The scolex is almost globular with its rostellar part slightly protruding at its apical region. The scolex measures 0·28 in maximum diameter. Rostellum, well developed and measuring 0·12 in diameter, bears ten rostellar hooks of 0·023-0·025 length. The guard of the rostellar hook is fairly short and stout while its handle and the point are comparatively thinner and indicate slight flexure at the free ends. The rostellar sac, measuring 0·10 in maximum diameter, extends upto the anterior margin of the suckers. Suckers, well developed and almost spherical in form, measure 0·091-0·110 in diameter. Genital pore unilateral and located either at the centre of the proglottis margin or slightly anterior to it. Genital cloaca is insignificant and is poorly represented. Cirrus sac, fairly prominent and extending to the ventral longitudinal excretory vessels, sometimes just crossing it, measures 0·15-0·19 × 0·042-0·077. External and internal vesiculae seminalis well developed and measure 0·17-0·31 × 0·062-0·082 and 0·117-0·152 × 0·034-0·042 respectively. Testes (maximum diameter 0·145) are arranged in a triangular pattern as a normal occurrance. Only one testis is usually poral (normal pattern) and is located in posterior half of the segment almost touching the posterior border of the segment. Of the two aporal testes, one is anterior and rather external to the other (posterior one) ; sometimes it (anterior and aporal testis) is located either just infront of the posterior testis or slightly internal to it. The ovary is distinctly

TABLE 1.—The variations in testicular arrangements in relation with the position of ovary and the genital pore in *Hymenolepis lanceolata* (Goeze, 1782).

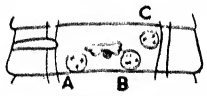
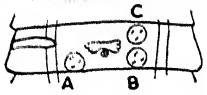
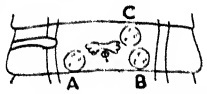
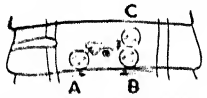
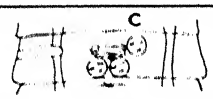
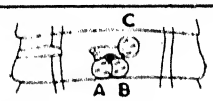
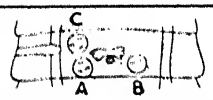
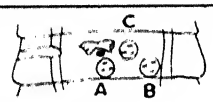
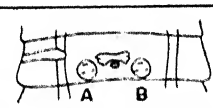
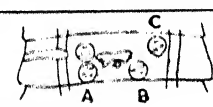
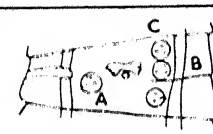
No.		Arrangement of genital organs.	Pattern	Explanation
I	*a*		Usual	Normal occurrence.
	b		Usual + Variant	Anteriorly placed aporal testis comes just anterior to posterior aporal testis.
	c		Usual + Variant	Anteriorly placed aporal testis comes slightly internal to posterior aporal testis.
II	*a*		Variant	Posteriorly placed two testes (A & B) migrate inward, thus approaching each other. Anteriorly placed aporal testis also approaches the ovary.
	b		"	Posteriorly placed two testes (A & B) almost touch each other and anterior aporal testis (C) also touches the ovary.
	c		"	Posteriorly placed two testes (A & B) overlap partially each other and anterior aporal testis (C) overlaps a part of the ovary.
III			"	Anterior aporal testis completely missing. Anterior poral testis, a new condition is established.
IV			"	Another new condition is acquired: ovary takes a new position, poral and anterior to posterior poral testis. All the three testes show a triangular pattern, testis (C) being centrally located anterior to testes (A & B).
V			Reduction to 2 testes	*Diorchis* type: only two posteriorly placed testes present, the third one completely missing.
VI			Addition to 4 testes	*Oligorchis* type: addition of one more testis, poral and anterior to poral posterior testis.
VII			Abnormal	Proglottis margin on poral side indicates a single segment, while two segments are formed aporally: thus affecting the growth of the genital organs. Posterior segment having only single testis as a representative of the genital organs.

Key to symbols— O Ovary Testis ▬ Genital pore

TABLE ____ 1

THE VARIATIONS IN TESTICULAR ARRANGEMENTS IN

HYMENOLEPIS FARCIMINOSA (GOEZE, 1782)

No.		Arrangement of genital organs.	Pattern	Explanation.
I	a		Usual	Normal occurrence.
	b		Usual & variant	C _ moves anterior to B.
	c		Usual & variant	C _ slightly internal to B.
II	a		Variant	A & B _ migrate inward
	b		Variant	A & B _ move further & meet each other.
	c		Variant	A & B _ overlap partially, C _ overlap ovary in part.
III			Variant	C _ completely missing on aporal side, but established as a poral testis.
IV			Variant	Ovary poral (new condition) C _ centrally located ($\triangle^{or}$ pattern)
V			Reduction to 2 testes	Diorchis type : C _ missing
VI			Addition to 4 testes	Oligorchis type : one more (poral) testis added.
VII			Abnormal	Poral side __ single segment. Aporal side __ two segments. Posterior segment affected in genital organs.

bilobed and is located approximately in the centre of the proglottis. Receptaculum seminis, although small, is easily distinguishable and is located in close association with the ovary. Uterus is an irregular sac-like structure filling up the whole segment except the lateral margins. Eggs and onchospheres measure 0·034-0·038 and 0·019-0·025 in diameter respectively.

In spite of several differences which are only of minor importance, the present form is, therefore, listed under the above name.

OBSERVATIONS ON THE TESTICULAR PATTERNS

A thorough survey of the strobilae revealed interesting variation in the pattern of the testicular arrangement indicating a distinctive contrast from the usual type as mentioned above. All the available patterns are given in Table 1. It is, therefore, essential to pay a thorough attention by careful study to this particular character to avoid unnecessary creation of new forms.

SUMMARY

Hymenolepis farciminosa (Goeze, 1782) is reported from *Acridotheres tristis* (L. 1766). The worms measure 115·0 in length and 1·50 in breadth. The scolex is globular, bearing well developed rostellum and the suckers. The rostellar hooks number ten and measure 0·023-0·025 in length. The guard of the rostellar hooks is fairly short and stout. Suckers measure 0·091-0·110 in diameter. Genital pore is unilateral. Cirrus sac extends to the ventral longitudinal excretory vessel, sometimes just crossing it and measures 0·15-0·19 × 0·042-0·077. External and internal vesiculae seminalis well developed and measure 0·17-0·31 × 0·062-0·082 and 0·117-0·152 × 0·034-0·042 respectively. Testes (maximum diameter 0·145) are arranged in a triangular pattern as a normal occurrance. Ovary, distinctly bilobed, is located approximately in the centre of the proglottis. Uterus is an irregularly sac-like structure. Eggs and onchospheres measure 0·034-0·038 and 0·019-0·025 in diameter respectively. It is noteworthy to mention that the occurrance of the present form is the first record from Delhi State.

The paper also includes interesting observations on the variation in the patterns of testicular arrangement indicating distinctive contrast from the usual type as given in the accompanying Table.

ACKNOWLEDGMENTS

The author is greatly indebted to Professor M. L. Bhatia for the facilities to carry out the work in the Department of Zoology, University of Delhi. Thanks are also due to C. S. I. R. for the financial assistance.

REFERENCES

Fuhrmann, O., (1932). Les Tenias des oiseaux. *Mem. de la Univ. de Neuchatel.*

Johri, L. N., (1950). Report on Cestodes collected in India and Burma. *Ind. Jour. Helm.*, Vol. 11, No. 1, 23-24.

Mayhew, R. L., (1925). Studies on the avian species of the cestode family Hymenolepididae. *Illinois Biol. Monog.*, 10, 1-125.

Meggitt, F. J., (1926). On a collection of Burmese cestodes. *Parasit.*, 18, 230-237.

Southwell, T., (1930). The Fauna of British India, including Ceylon and Burma, Cestoda, 2.

Wardle, R. A. and McLeod, J. A., (1952). The Zoology of Tapeworms, Minneapolis.

EFFECT OF PHOTOPERIOD ON CARBOHYDRATE/NITROGEN METABOLISM IN TWO VARIETIES OF PADDY

By

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INTRODUCTION

In an earlier contribution (Das, 1958) the author reported changes in carbohydrate/nitrogen fractions following long-day treatment of wheat plants. In this paper the results of more or less similar experiments on two varieties of paddy have been presented. According to Kar and Adhikary (1945) winter variety of paddy exhibited earlyness in flowering when given short-day light treatment. Sircar and Ghosh (1947), contrariwise, observed that short-day treatment delayed flowering in the summer variety. Likewise, Misra (1950, 1951) reported that short-day light period induced opposite effects in two varieties of paddy. None of these workers, however, studied the physiological changes accompanying differences in the reproductive behaviour of plants. The present studies were made in that direction.

The significance of the concept of C/N balance in plants was advanced by Klebs and later stressed by Kraus and Kraybill. Garner *etal* (1924) viewed that the light period influences the acidity relations, the form of carbohydrates and probably the water content of the tissues in plants. According to Deats (1925) differences in exposure to day length influence plant development through a change in nitrogen/carbohydrate flux. Hurd-Karrer and Dickson (1934) observed highest carbohydrate and lowest nitrogen percentage in the leaves of wheat plants exposed to long days.

MATERIAL AND METHOD

Pure strain desease free seeds of paddy (*Oryza sativa* L.) varieties—T 64 (early) and T 36 (late) were selected for uniformity and sown simultaneously in different lots in nursery beds having as homogeneous a substratum as possible. Twenty days later they were transplanted in earthenware pots (11″ × 9″) filled with richly manured garden loam. Only three plants were allowed to grow in each pot. A fortnight after transplantation, when the seedlings were well established, treatment commenced. Half the number of pots from each variety were kept in natural sunshine for a period of 8 hours daily from 8 a. m. to 4 p. m. and, thereafter, removed to a dark, airy room. The remaining half were allowed to grow in the full period of normal day light. This latter lot served as control.

Healthy, green and well developed leaves of approximately the same age and expansion were sampled out from each lot at fortnightly intervals, four times in the life cycle of the plants. These were designated as stages I, II, III and IV respectively. The sampled leaves were duly killed and analysed for soluble carbohydrate (hexoses and sucrose) and total soluble nitrogen. Sugars were estimated by

Somogyi's method (1945) and total soluble nitrogen by Kjeldhal method (A. O. A. C., 1945). Since Das (1958) observed that the soluble forms of carbohydrates and nitrogen exhibit better correlations with the flowering behaviour of the plants only the soluble forms were determined in this investigation. All determinations were made in duplicate and average reported in each case. All observations were statistically computed. Analysis of variance was worked out and the significance of the results determined using 'F' test.

EXPERIMENTAL RESULTS

It was observed that in the plants of *var.* T 64 (early variety) exposed to normal sun-shine as much as 50 percent ear emergence occured 43 days after transplantation, while in those subjected to 8 hour photoperiod it began 47 days after. Ear emergence was thus delayed by four days in plants subjected to short-day light period. The crop is normaly planted in the beginning of June. Apparently, therefore, due to late plantation, the difference in the ear emergence in the two cases was not much marked.

In *var.* T 36 (late), ear emergence was contrariwise, hastened by 14 days following exposure to 8 hours light period. It was found that 50 percent of the control plants flowered 60 days after transplantation, while the short-day lot did so 46 days after.

Sugars: The control and the treated series did not exhibit any difference in their chemical make up at the first stage, 15 days after transplanting. The control plants of early variety were marked with an increase in hexose content with increase in age upto 45 days and thereafter, a significant fall was registered (Table I). Maximum hexose in the leaves was recorded at the time of flowering in control plants but in treated ones it stood at maximum 60 days after transplanting.

The control plants of the late variety (T 36) also behaved in a manner similar to that of the early variety in changes in hexose content throughout the life cycle. The hexose content of the late variety was lower than that of the early at all the stages in the control plants. The treated plants of the late variety behaved in a manner similar to the control of the early variety in that the hexose content showed a rise upto 45 days and subsequently a fall. Thus the treatment was able to induce changes in the sugar content quantitatively in both the varieties but the trend of the change with the age was different only in the early one (Table I).

Table I. HEXOSE

(*Fresh basis, gm. per 100 gm.*)

Growth stages (Age)	Early Control	Early Treated	Late Control	Late Treated
I (15 days)	0·15	0·15	0·06	0·06
II (30 days)	0·42	0·12	0·27	0·12
III (45 days)	0·87	0·06	0·63	0·45
IV (60 days)	0·18	0·90	0·15	0·18
	S.E. 0·143	C.D. at 5% 0·457	C.D. at 1% 0·657	

Table II. SUCROSE

(Fresh basis, gm. per 100 gm.

Growth Stages (Age)	Early Control	Early Treated	Late Control	Late Treated
I (15 days)	1·41	1·41	1·53	1·53
II (30 days)	1·38	0·75	1·39	0·72
III (45 days)	3·93	1·71	2·67	3·75
IV (60 days)	2·91	2·58	2·28	4·11

S.E. 0·304 C.D. at 5 . 0·972 C.D. at 1% 1·397

Table III. TOTAL SUGARS

(Fresh basis, gm. per 100 gm.)

Growth stages (Age)	Early Control	Early Treated	Late Control	Late Treated
I (15 days)	1·56	1·56	1·59	1·59
II (30 days)	1·80	0·87	1·69	0·84
III (45 days)	4·80	1·84	3·30	4·20
IV (60 days)	3·09	3·48	2·43	4·29

S.E. 0·391 C.D. at 5 1·251 C.D. at 1% 1·797

Table IV. TOTAL SOLUBLE NITROGEN

(Fresh basis, gm. per 100 gm.)

Growth stages (Age)	Early Control	Early Treated	Late Control	Late Treated
I (15 days)	0·132	0·132	0·154	0·154
II (30 days)	0·133	0·132	0·183	0·143
III (45 days)	0·084	0·116	0·204	0·150
IV (60 days)	0·042	0·122	0·105	0·140

S.E. 0·0169 C.D. at 5% 0·0543 C.D. at 1% 0·0781

Sucrose values rose gradually from the second upto the last stage in treated early variety whereas in control it declined after 45 days (Table II). In late variety also the treated plants showed a highly significant rise between 30 and 45-day period after which the increase was insignificant. Control plants of late variety behaved in a way similar to the control of early variety except for the fact that the magnitude of change was much less and the value at the 45-day stage was significantly higher in early variety as compared to the late variety.

Total sugar values showed a significant rise in the control plants of both the early and the late varieties upto the 45-day stage and, thereafter, a fall (Table III). In the case of treated plants of both early and late varieties, a decline was observed at the second stage synchronizing with the 30-day age as compared to the first stage which, however, was insignificant. Beyond the 30-day stage a significant increase in the total sugar percentage was observed in both the varieties.

Nitrogen: Soluble nitrogen exhibited a regular and significant fall from the first to the last sampling date in control plants of the early variety whereas treated plants showed minimum quantity in 45 days old plants which was significantly lower than the first stage when plants were 15 days old (Table IV). In the control plants of the late variety there was a rise upto 45 days after which a highly significant decrease was seen. Comparing it with treated ones it was observed that there was an insignificant difference between the different stages although maximum fall was observed between 45 and 60-day stage. At the fourth stage control plants had lower values than treated ones of the same stage, in the case of both the varieties.

DISCUSSION

It is thus observed that short-day light treatment brings about early maturity in the late variety (T 36) and late maturity in the early variety (T 64) of paddy.

The control plants of the early variety flowered 4 days earlier than the treated ones, the former taking 43 days and the latter 47 days from the date of transplanting. The third date of observations coincided with the flowering of the early variety whether treated or otherwise. The percentage of hexose and sucrose was at a much higher level in control plants than in the treated ones (Table I & II); soluble nitrogen being more in the treated than in the control plants at the flowering stage (Table IV). In general, therefore, the soluble carbohydrate to soluble nitrogen ratio (SC/SN) was higher at the flowering time in both the treated and control plants. High C/N ratio was more pronounced in the control plants which flowered earlier showing the ascent of the ratio with the approach of maturity. The findings of Kraus and Kraybill (1918) and Gilbert (1926) are in line with the present one.

The sucrose content was higher in control than in treated plants at the fourth stage, 60 days after the transplanting; soluble nitrogen behaved in the reverse way since it was higher in the treated than in the cantrol plants of the early variety. Thus, a high SC/SN ratio in the control plants and low one in the treated plants was noticed. The high value of sugar in control was probably due to the fact that the sugars were being accumulated in the leaves for being translocated to the developing grains. However, at this stage the treated plants of the early variety were also following closely the control plants with regard to the SC/SN balance. This is indicated from the fact that in the early variety there was a much greater increase in the amount of hexose in the leaves of treated plants than in the control ones at the same stage. The treated plants thus, followed closely the control ones as far as the sugar percentage was concerned (Table I, II & III).

With regard to the late variety the dates of third and fourth sampling coincided with the flowering in treated and control plants respectively. It was observed that total sugars (Table III) especially the sucrose (Table II) was higher in treated plants at the flowering stage than the control plants at the 15 day stage. There being less of soluble nitrogen (Table IV) in treated plants than in control plants the SC/SN ratio was high in treated plants at the third stage (flowering) when ear emergence took place. An increase in the amount of reducing sugars was also reported just before ear emergence by Purvis (1934). Further, these results also confirm the findings of Kraus and Kraybill (1918) and Nightingale (1932) to the effect that a high C/N ratio existed in the plants at the time of ear emergence. At the fourth stage there was less of soluble nitrogen in the flowering control plants as compared to the treated plants which had flowered earlier. The percentage of sugars especially sucrose was also lower in control than in the treated plants. The high SC/SN ratio was not well marked in control plants at the fourth stage coinciding with the flowering. The increase in sugars at this stage in treated plants as compared to control plants seems to be due to the translocation of sugars to the developing grains of the treated plants. As reported earlier (Das, 1958) the SC SN balance in the plants specially after the attainment of reproductive phase was governed by the compositional nature of the seeds set by the plants. This control was brought about by the variations in the soluble sugars as observed in the case of carbohydrate rich paddy where the sugar percentage increased in both, the treated plants of the late variety and the control of the early variety, after the ear emergence. In the protein rich wheat plants the nitrogen increase at the time of seed formation governed the SC/SN balance (Das, 1958).

CONCLUSION

The observations as noted and discussed above lead to the conclusion that the short-day light treatment of eight hours forces early ear emergence in late variety and delays ear emergence in the early variety of paddy. This deviation in the ear emergence from the control ones is accompanied by a change in the soluble carbohydrate soluble nitrogen ratio (SC/SN). It has been found, in general, that the SC/SN ratio is high at the time of ear emergence in both the control and treated plants. Further, the SC/SN ratio remained at a high level even after ear emergnce since the ratio was governed to a considerable extent by the compositional nature of the seeds produced by the plants.

SUMMARY

1. Two varieties of paddy (*Oryza sativa* L.) namely T 64 an early variety and T 36 a late variety were grown in pots and given short-day light treatment of eight hours every day throughout the life cycle. Along with these a control receiving normal day-light was also maintained.

2. At four fortnightly intervals analysis of the leaves of the control and treated plants was done for hexose, sucrose and soluble nitrogen. The results were analysed statistically and the time of ear emergence in each series was also noted.

3. The treated plants of early variety recorded ear emergence four days late as compared to the control plants of the same variety. In case of the late variety the treated plants showed fourteen days early ear emergence as compared to control plants.

4. The effect of short-day light treatment on the soluble carbohydrate soluble nitrogen fraction (SC/SN) has been reported and discussed fully in the text.

5. A high SC/SN ratio was found to be associated with the ear emegence and after the ears had emerged out this ratio was conditioned by the compositional nature of the seeds to be produced.

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REFERENCES

A. O. A. C. 1945. Methods of analysis of the Association of Offical Agricultural Chemists, Washington 4, D.C. Sixth Ed., P. 27.

Das, N. 1958. Effect of photoperiod on growth. ear emergence and carbohydrate nitrogen metabolism of wheat. *Proc. Nat. Ac. Sci.*. (India) 28B: 90-96.

Deats, M. E. 1925. The effect on the plants of the increase and decrease of the period of illumination over that of the normal day period. *Amer. J. Bot.*, 12: 384.

Garner, W. W., Allard, H. A. and Bacon, C. W. 1924. Photoperiodism in relation to hydrogen ion concentration of the cell sap and the carbohydrate content of the plant. *J. Agr. Res.*, 27: 119-156.

Gilbert, B. E. 1926. Interrelation of relative day length and temperature. *Bot. Gaz.*, 81: 1-24.

Hurd-Karrer and Dickson, A. D. 1934. Carbohydrate and nitrogen relations in wheat plants with reference to type of growth under differential enviornmental conditions. Plant Physiol, 9: 533-565.

Kar, B. K. and Adhikary, A.K. 1945. Phasic development of paddy. *Science and Culture*, 10: 506-508.

Kraus, E. J. and Kraybill, H. R. 1918. Vegetaton and reproduction with special reference to tomato. *Oregon Agric., Exp. Sta. Bull.*, 149.

Misra, G. D. 1950. Effect of photoperiod on the flowering time of two late varieties of paddy. *Curr. Sc*, 19: 126-127.

..... 1951. Photoperiodic response in some early varieties of paddy. *Ibid.*, 20: 209-210.

Nightingale G. T. 1922. Light in relation to the growth and chemical composition of some horticultural plants. *Proc. Amer Soc. Hort Sci*, 19: 18-29.

Purvis, O. N. 1934. An analysis of the influence of temperature during germination on the subsequent development of certain winter cereals and its relation to the length of day. *Ann. Bot.*, 48: 919-955.

Sircar, S. M. and Ghosh, B. N. 1947. Effect of high temperature and short days on vernalization response of summer varieties of rice. *Nature*, 159: 605.

Somogyi, M. 1945. A new reagent for the determination of sugars. *J. Biochem.*, 61.

THE MOIST DECIDUOUS FORESTS OF THE POONA DISTRICT

By

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Botanical Survey of India, Poona

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Uptil 1950 very little work was done on the botany of the Poona district. After the publication of Cooke's Flora of Bombay in 1902, lists of plants of some areas were published, with or without short descriptions (Santapau, 1951, 1953; Razi 1952; Vartak 1953). No exhaustive work was however done on the flora of the district, and no ecological work was attempted on its vegetation. A reconnaissance survey of the district revealed that it has six main vegetation types viz. Evergreen Forests, Moist Deciduous Forests, Dry Deciduous Forests, Scrub Forests, Grasslands and Swampy and Marshy vegetation. Puri (1957); Puri and Patil (1957); Puri and Jain (1958 a, b, 1959); Puri and Vasavada (1958) and Puri and Mahajan (1958).

The moist deciduous forests of the Poona district occur usually on basaltic hills in the high rainfall areas, chiefly on northern and north-eastern slopes, and in depressions. In some spots the north-western slopes also have similar vegetation. The basalts and amygdaloids in the Deccan Trap area dip slightly towards the east and north-east and it is possible that the eastern and north-eastern slopes have more moisture due to seepage effect.

The moist deciduous forests were studied in detail at Paud and Mulshi, (Plate 1, ph. 1 and 2) about thirty miles south-west of Poona. (Map 1)

The hills in these areas are mainly of plateau type, flat topped and precipitous on sides. The flat tops have either grasslands or a scrubby vegetation, which are chiefly biotic or bio-edaphic in origin. The slopes have shallow soil towards the top, with boulders of basalt lying scattered on the surface or embedded in the soil. The depth of soil varies between 15 to 30 cms. or so, and the colour is predominantly black or greyish black.

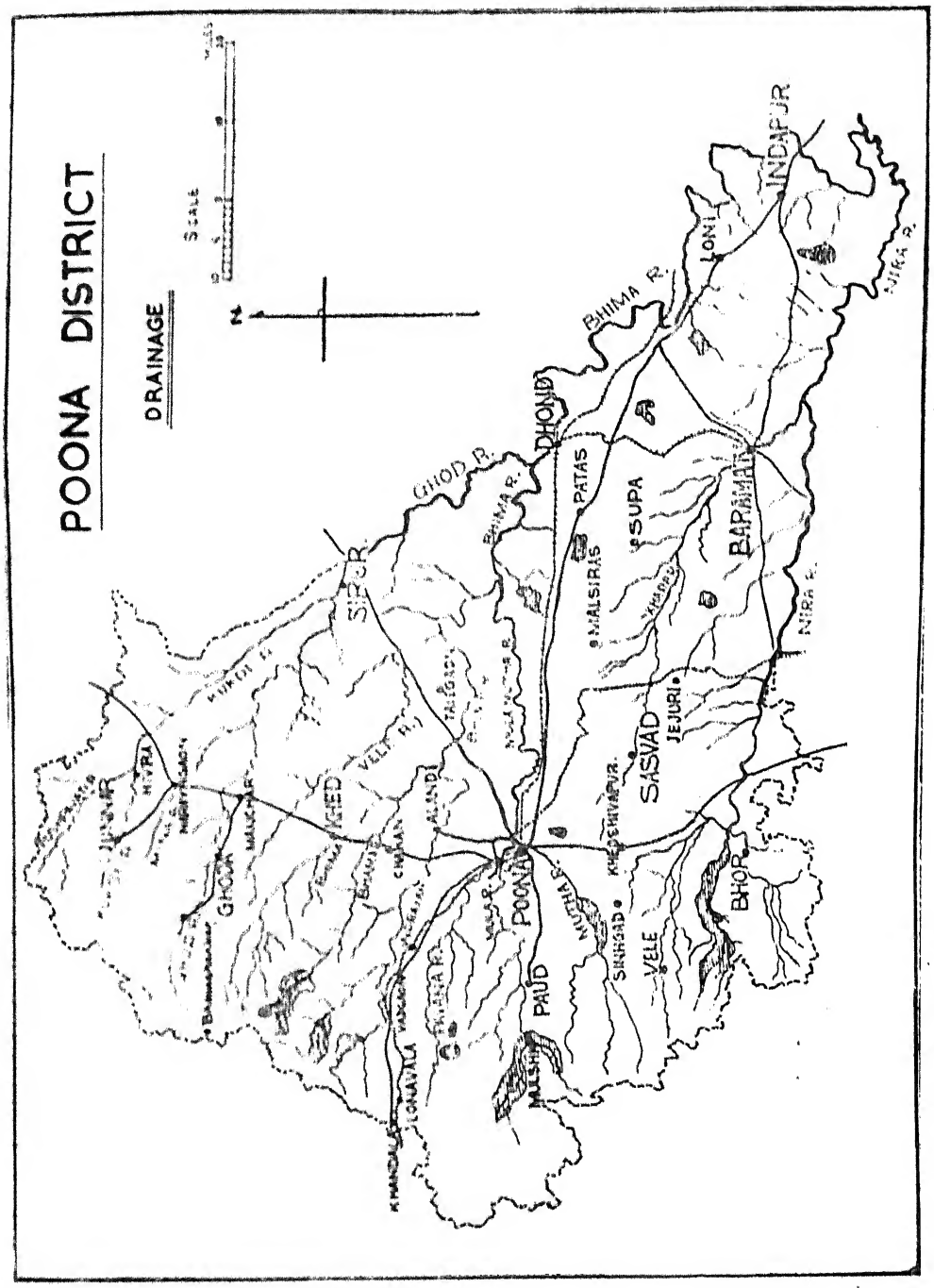
The area is greatly disturbed by human factor, through felling lopping, and burning.

The vegetation was studied by first making plant collections and then running a number of transects in the area, in general by the methods suggested by Misra and Puri (1957). The percentage occurrences of various species were determined and are given in table 1.

The moist deciduous forest is formed chiefly of Teak, *Terminalia* and *Syzygium* communities. The trees in the upper storey reach to a height of about 5—10 meters, forming a sparse canopy. Other common species in the upper storey are *Erythrina variegata, Cordia dichotoma.* Due to moisture conditions these species remain in leaf till the beginning of winter, i. e., about the end of November.

The tree trunks are not covered with any hanging mosses, ferns or orchids. Terrestrial ferns also are not many. The second storey includes species of *Zizyphus, Acacia, Lagerstroemia, Ficus* and also *Cordia.* Common climbers are *Smilax, Cissus, Celastrus, Cissampelos, Cocculus, Cryptolepis* and *Hemidesmus. Acacia torta* occurs in some areas.

MAP 1


POONA DISTRICT
DRAINAGE
SCALE
N
BHIMA R.
GHOD R.
DHOND
PATAS
MALSIRAS
SUPA
BARAMATI
INDAPUR
LONI
NIRA R.
SIRUR
SASVAD
JEJURI
BHOR
VELE
PAUD
POONA
GHOD
JUNNAR
KHED
MULSHI

The scrub layer consists of *Carissa congesta, Lantana camara, Woodfordia fruticosa, Pavetta indica, Carvia callosa,* and *Euphorbia.*

The ground cover of herbs and grasses has a number of seedlings of Teak, *Terminalia* and *Syzygium* and *Ficus,* indicating that the community would progress to Teak, *Terminalia, Syzygium* community.

The alluvial soil at the base of hill slopes along valleys supports even trees of *Terminalia chebula, Pongamia pinnata* and *Bridelia retusa.*

The vegetation of different spots studied is given briefly below.

TABLE 1

Locality and Aspect	Shera Paud hills, Western slope.	Lonavla Bhoma hill Eastern slope	Paud North slope	Paud shera North Western.	Paud II spot North.	Kolwan North.	Kolwan II North.	Paud Western.
1	2	3	4	5	6	7	8	9
Geology, soil	Trap, rocks basaltic soil blackish or grey	Basaltic rock, soil greyish.	Basaltic rock, soil greyish.	Basaltic rock, soil greyish.	Basaltic rock, soil greyish.	Basaltic rock, soil deep, chocolate colored or greyish.	Basaltic rock, soil deep, chocolate colored or greyish.	Basaltic rock, soil deep, chocolate colored or greyish.
Biota	Open to grazing lopping etc.	Open to grazing.	Open to grazing.	Open to grazing.	Open to grazing.	Open to grazing.	Open to grazing.	Open to grazing.
Details of quadrats	14quadrats of 5m. radius. %	20 quad rats of 5m. radius. %	20 quadrats of 5m. radius. %	10 quadrats of 5m. radius. %	10 quadrats of 5m. radius. %	5 quadrats of 5m. radius. %	10 quadrats of 5m. radius. %	10 quadrats of 5m. radius. %
Acacia arabica	—	—	15	—	—	—	—	—
Acacia chundra	28	—	20	—	22	—	—	—
Acacia torta	7	—	5	—	—	100	40	—
Acacia pennata	—	—	—	30	—	—	—	—
Albizzia lebbeck	—	—	—	10	—	—	—	—
Albizzia procera	—	—	5	—	—	—	20	—
Bridelia retusa	—	10	—	—	—	20	—	—
Careya arborea	7	30	—	—	—	—	10	—
Cassia fistula	—	—	5	10	—	—	—	—
Cordia dichotoma	—	—	5	—	—	—	—	—
Dalbergia lanceolaria	—	—	—	10	—	—	—	8

TABLE I—(*Contd.*)

1	2	3	4	5	6	7	8	9
Embelia tssjarium-cottam	—	—	—	—	—	20	—	—
Emblica officinalis	—	—	—	—	—	—	20	16
Erinocapus nimmonii	—	—	—	—	—	—	10	—
Erythrina variegata var. orientalis	14	10	10	10	—	40	70	—
Ficus sp.	7	—	—	—	—	—	10	8
Glochidion sp.	—	10	—	—	—	—	10	—
Gmelina arborea	—	—	5	—	—	—	—	—
Grewia tiliaefolia	7	10	—	20	—	—	—	24
Lannea coromandelica	—	—	—	10	—	20	—	8
Mangifera indica	—	5	—	10	—	—	20	8
Meyna laxiflora	—	30	—	60	—	—	—	—
Osyris wightiana	—	—	20	10	—	—	10	32
Pongamia pinnata	—	—	—	—	—	40	—	—
Randia brandisii	—	—	—	30	—	—	—	—
Salmalia malabarica	7	—	15	10	—	—	20	—
Syzygium cumini	7	—	5	30	—	—	10	8
Syzygium jambos	—	—	—	50	—	—	—	—
Tectona grandis	—	—	15	—	44	—	—	40
Terminalia chebula	—	5	—	—	—	20	30	—
Terminlia tomentosa	21	50	20	30	11	—	10	16
Zizyphus rugosa	7	50	5	60	22	40	—	—
Zizyphus xylopyrus	7	—	25	10	—	—	50	8
Artemisia sp.	—	—	25	—	33	—	20	40
Asparagus racemosus	14	—	10	70	—	20	10	16
Carvia callosa	7	20	35	—	—	—	10	16
Carissa sp.	28	30	10	100	11	80	70	16
Celastrus paniculatus	—	—	5	—	—	—	20	16
Cissampelos sp.	—	—	5	—	—	—	—	—

TABLE 1—(*Contd.*)

1	2	3	4	5	6	7	8	9
Cissus sp.	7	—	—	10	—	40	40	—
Clematis triloba	—	—	—	10	—	—	10	—
Clerodendron serratun	14	—	5	—	—	20	10	8
Cryptolepis buchanani	7	10	10	70	—	40	—	—
Cymbopogon martinii	—	—	20	—	—	20	30	48
Dioscorea oppositifolia	—	—	5	20	11	—	40	24
Dichanthium annulatum	—	—	15	—	—	—	—	—
Euphorbia neriifolia	—	—	5	—	22	80	40	8
Flacourtia montana	7	20	15	90	11	40	—	—
Grewia abutilifolia	—	—	—	70	—	40	—	—
Gymnosporia spinosa	—	10	—	—	—	—	10	24
Hemidesmus indicus	—	—	5	—	—	—	—	—
Heteropogon sp.	—	60	10	—	55	60	20	56
Holarrhena antidysenterica	—	10	—	60	—	—	20	—
Iseilema sp.	—	50	25	—	—	20	—	—
Ischaemum sp.	—	40	5	—	—	—	50	32
Lantana camara	21	20	50	100	44	100	40	100
Lasiosiphon eriocephalus	—	20	10	40	—	40	40	32
Leea sp.	—	—	5	—	—	—	—	—
Mucuna sp.	—	—	—	—	—	20	—	—
Pavetta indica	14	10	—	60	—	60	70	—
Pseudanthistiria hispida	—	—	—	—	—	—	—	48
Rivea hypocrateriformis	—	—	5	—	—	—	—	—

TABLE 1—(*Concld.*)

1	2	3	4	5	6	7	8	9
Securinega virosa	—	—	—	50	—	40	20	8
Smilax sp.	49	10	—	100	11	100	68	—
Themeda sp.	—	—	—	—	33	80	20	72
Tinospora cordifolia	—	—	—	—	—	—	20	—
Triumfetta sp.	—	—	20	—	—	—	—	—
Urena lobata	—	—	—	—	—	80	70	—
Vitis sp.	—	10	—	—	—	20	—	—
Woodfordia fruticosa	7	30	15	20	—	60	60	—
Zizyphus mauritiana	—	—	5	—	—	—	—	—
SEEDLINGS								
Acacia	—	—	15	—	—	—	—	—
Careya	—	—	—	—	—	—	10	—
Dalbergia	—	—	—	—	—	20	16	—
Lagerstroemia	—	—	35	—	—	—	—	—
Madhuca	—	—	15	—	—	—	—	—
Mangifera	—	—	—	—	—	20	—	—
Pongamia	—	—	20	—	—	40	—	—
Salmalia	—	10	5	—	—	20	40	—
Semecarpus	—	—	20	—	—	—	—	—
Syzygium	—	15	10	—	—	40	10	—
Terminalia	21	30	40	—	11	—	10	32
Zizyphus	—	—	5	—	—	—	—	—

SHERA

Shera is a small village between Paud & Mulshi (Plate 2 ph. 2). The hills on the south of the village were explored. The slope is gentle and there are terraces of old abandoned cultivation. Due to biotic interference the tree vegetation is poor. Trees of *Terminalia tomentosa*, *Erythrina variegata* and *Acacia chundra* are commonest. Regeneration of these trees is good. There are a number of shrubs such as *Lantana camara*, *Carissa congesta*, *Pavetta indica*, *Clerodendron serratum*, *Carvia callosa* etc. *Smilax*

spp. are commonest climbers. Some seedlings of *Cordia dichotoma, Salmalia malabarica,* were also observed. In general the forest is very poor.

BHOMA HILL

This hill is situated towards the south of Lonavla town (Plate 2, ph. 1). The eastern slope was studied. There is a greater variety of vegetation here. The number of tree species is less. *Terminalia tomentosa, Careya arborea, Zizyphus rugosa,* are frequently met with. The shrub layer is very dense and is composed of a number of spiny and other shrubs and grasses. Common shrubs are *Lavisiphon eriocephalus, Meyna laxiflora, Flacourtia ramontchi, Carissa congesta, Woodfordia fruticosa, Carvia callosa, Gymnosporia spinosa, Lantana camara.* The commonest grasses are species of *Heteropogon, Iseilema, Ischaemum,* and *Themeda.*

PAUD

The hills at Paud were studied by a number of transects. The hill tops are flat and some times under cultivation. They are usually poorer in tree growth. The slopes have good tree growth. At some places in the lower parts of the slope the forest department has undertaken reforestation of teak and other species.

The lower parts of the slope nearer to the town are covered with *Lantana* bushes.

Zizyphus species are also common in lower parts of slopes. The commonest trees on this spot are *Tectona grandis* (Pl. 1, ph. 1) *Terminalia tomentosa, Salmalia malabarica, Zizyphus xylopyrus, Acacia chundra.* Some trees of *Cordia dichotoma, Syzygium cumini* and *Terminalia chebula* were also observed. *Osyris wightiana* is a common plant here. Nearer to the top *Artemisia* and *Carvia* are the commonest shrubs. The top is an open grassy flat area. *Arthraxon* and *Apluda* are the commonest grasses.

Another spot studied near Paud was a plateau near the top of the hill. The commonest plants here are *Lantana, Lavisiphon, Artemisia, Gymnosporia* and many grasses. Coming down towards the foot of the hill the gradient of the slope is first high and the soil is dry, gravelly and shallow. The vegetation is generally sparse. Further down the slope is gentle and the soil is deep, moist and covered with humus. Plants of teak, *Terminalia, Osyris, Artemisia, Phyllanthus, Lannea coromandelica, Madhuca indica, Salmalia malabaricum,* and *Grewia* spp., are present. Teak regeneration is common.

There is heavy grazing on lower slopes and the vegetation is poor.

KOLWAN

The vegetation of Kolwan hills was studied at two spots. The soil here is deep, greyish or chocolate in colour with considerable amount of humus.

The commonest tree species are *Erythrina variegata, Salmalia malabarica, Mangifera indica, Albizzia* sp., *Terminalia chebula.* The shrubs of *Securinega virosa, Zizyphus xylopyrus, Woodfordia fruticosa Carissa congesta, Lavisiphon eriocephalus, Euphorbia neriifolia, Pavetta indica, Lantana* are commonest. The common climbers are *Acacia torta, Smilax, Celastrus paniculatus, Tinospora cardifolia, Dioscorea oppositifolia, Holarrhena antidysenterica.*

The ground is covered by seedlings of the tree species and a number of herbs and grasses. *Barleria, Ischaemum* and *Urena* are common plants in the undergrowth.

PLATE I

Photo 1. Teak forest on north slope of Paud hill.

Photo 2. Interior of a moist deciduous forest at Mulshi. Vegetation of *Albizzia, Termina'ia* and *Dioscorea*, with dense undergrowth.

PLATE 2

Photo 2. Forest at Mulshi, dense vegetation of *Albizzia, Grewia, Cissus* and *Smilax.*

Photo 1. [illegible] slope of [illegible] Hill at [illegible] forest [illegible]

At another spot near Kolwan, *Pongamia pinnata* was observed as a common plant near the foot of the hills in valleys. *Terminalia chebula* is present on lower and middle slopes. *Erythrina variegata* and *Bridelia retusa* are common on middle and upper slopes. *Acacia torta, Lantana camara, Smilax zeylanica* and *Carissa congesta* are very common all over, and they make the second storey in the forest very spiny and inaccessible. *Euphoebia neriiforia, Woodfordia fruticosa*, are other common shrubs. The saplings of *Syzygium cumini, Pongamia pinnata, Mangifera indica, Salmalia malabarica* and *Cordia dichotoma* were commonly seen. *Heteropogon contortus, Themeda, Bothriochloa pertusa, Urena lobata* and *Barleria* are common in the ground flora.

The moist deciduous forest in the Poona district shows various stages of vegetation between dry deciduous forests and the evergreen forests. The dry deciduous forets are more common all over the district.

The biotic interference arrests the progress of the mixed deciduous forest to any better stage of the vegetation. The soil and the rainfall are such that a good moist deciduous or mixed evergreen forest can grow in these situations.

These forests are of great economic value. Apart from the supply of timber from Teak and *Terminalia*, these forests give a regular supply of fuel and fodder. Several minor forest products such as tannins and fibres can be extracted from these forests. A number of valuable medicinal plants grow in them such as *Terminalia chebula, Asparagus racemosus, Hemidesmus indicus, Artemisia parviflora, Madhuca indica, Cissampelos pareira, Cocculus hirsutus, Holarrhena antidysenterica, Tinospora cordifolia, Vitex negundo, Cymbopogon spp., Celastrus paniculatus, Embelia tsjarium-cottam*, etc.

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REFERENCES

Misra, R, and Puri, G. S. 1957. Indian Manual of Plant Ecology. English Book Depot-Poona—1.

Puri, G. S. 1957. The introductory account of the Vegetation of Poona district, TSS. (unpublished)

Puri, G. S. and Jain, S. K. 1958. (a) Dry Scrub Vegetation of Poona District. *Proc. Nat. Instt. Sc.* (under publication).

Puri, G. S. and Jain, S. K. 1958. (b) Scrub Vegetation under Forest Management at Dhond, Poona, *Proc. Nat. Instt. Sc.* 24 B (3)—145 - 149.

Puri, G. S. and Jain, S. K. 1959. Flora of the Deccan Trap. *Proc. Ind. Sc. Cong. Pt.* III - 293.

Puri G. S. and Mahajan S. D. 1958. Vegetation of Marshes and Swamps in Poona District *Proc. Nat. Instt. Sc.* 24 B (3)—159 - 164.

Puri, G. S. and Patil, R. M. 1957. Dry Deciduous Scrub Vegetation of Poona. *Proc. Ind. Sc. Cong.* III, 290.

Puri, G. S. and Vasavada, J. 1957. Evergreen Vegetation of Poona District. TSS Communicated to *Rec. Bot. Sur. of India.*

Razi, B. A. 1952. Some aspects of the vegetation of Poona and neighbouring districts. *Poona University Journal* 1, (2), p. 57.

Santapau, H. 1953. Flora of Khandala. *Rec. B. S. I.* XVI (1) - 1 - 396.

Santapau, H. 1951. Flora of Sinhgadh Hill *Poona Agricultural College Magazine*, 41 - 279 - 284.

Vartak, V. D. 1953. Flora of Torna Hill. *Poona Univ. J.*, 4, 1 - 10.

THE CONCEPT OF MATURATION IN INDIAN SOILS

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[Read at the 28th Annual Session of the Academy held at the Agra University on 8th February 1959]

"The soils of India are essentially mineral soils with very little humus and without a characteristic profile development."—Misra and Puri (1957). In the present paper an attempt has been made to gauge the validity of this statement with reference to Madhya Pradesh soils.

Maturation of soil is a result of interaction of many factors over a long period of time. The controlling factors assigned are climate, vegetation and parent rock. Soil workers have often used such terms as old and young soils, mature and immature soil or stabilised and fresh soil. In their definitions they have evidently concentrated on the chemical stages in leaching. Thus, a mature or stabilised soil has been defined as having full development of A and B horizons in equilibrium with the prevailing weathering forces. Chemically the degree of leaching results in the development of roughly three types of soils as recognised by many authors *viz.* lime deficient, base deficient and acid soils.

In order to evaluate the chemical status of soils of Madhya Pradesh profile studies were undertaken in grasslands and forests. Only the following representative profiles will be described here (the readings are average figures) :—

A. UNDER GRASSLANDS—*Themeda Iseilema* association at Sagar.

B. UNDER FORESTS :—

(*i*) Sal M. P. quality I at S. Raipur and E. Jagdalpur.

(*ii*) Teak at Badwani.

(*iii*) Miscellaneous at Shahgarh and Nepanagar.

FOREST TYPES OF M. P. :

The vegetation of this state can be divided into 3 main forest types. Sal (*Shorea robusta*) occupies the eastern limits of the state interrupted by Chhattisgarh plains; Gwalior circle has thorn type of forests; and the rest of the state is covered with miscellaneous forests with or without teak (*Tectona grandis*).

CLIMATE OF M. P. :

Climate of the state is tropical. Based mainly on annual rainfall the state can be divided into 4 zones, *viz.*, (*i*) heavy rainfall with considerable humidity-rainfall 125 to 200 cm. (*ii*) good rainfall—100 to 125 cm. (*iii*) moderate rainfall—75 to 100 cm. and (*iv*) less to moderate rainfall—50 to 75 cm. Areas with heavy rainfall are under Sal; teak is on good to moderate rainfall and miscellaneous forest on moderate rainfall. Part of the state occupied with thorn scrub forest receives only 50 to 75 cm. of rains.

Soil was analysed by standard methods as outlined by Piper (1947) and Pandeya (1953).

*Work was conducted at Mahakoshal Mahavidyalaya, Jabalpur.

RESULTS AND THEIR INTERPRETATIONS

A. UNDER GRASSLANDS :

Locality - Sagar, foot-hill and valley. Usually such areas are deprived of forests due to their value for agriculture.

Geology—Deccan Trap. Black cotton soil or 'regur' and is comparable to 'chernozem'.

A_{oo} —fresh litter.

Top 10 cm.—Black, hard, cracked; cracks wedge shaped, narrow at the bottom.

Vegetation—*Themeda-Iseilema* association.

Month of sampling—*April*.

No.	Depth of sampling	pH value	Calcium carbonate in % of dry wt. of soil	Organic carbon in mg./100 gm. of soil.	Colour
1.	25 cm.	7·20	0·52	above 600	black
2.	30 cm.	7·96	0·50	600	grey
3.	120 to 150 cm.	8·70	38·08	less than 25	dirty white

From the above table it is clear that the profile shows a concentration of lime at the deeper depths. The character of the profile reflects that probably 'calcification' process is in progress in these soils. In calcification soluble and unstable bicarbonates of calcium are leached down and upon drying are collected as calcium carbonates in the deeper layers. Organic matter is less in these profiles (see fig. 1).

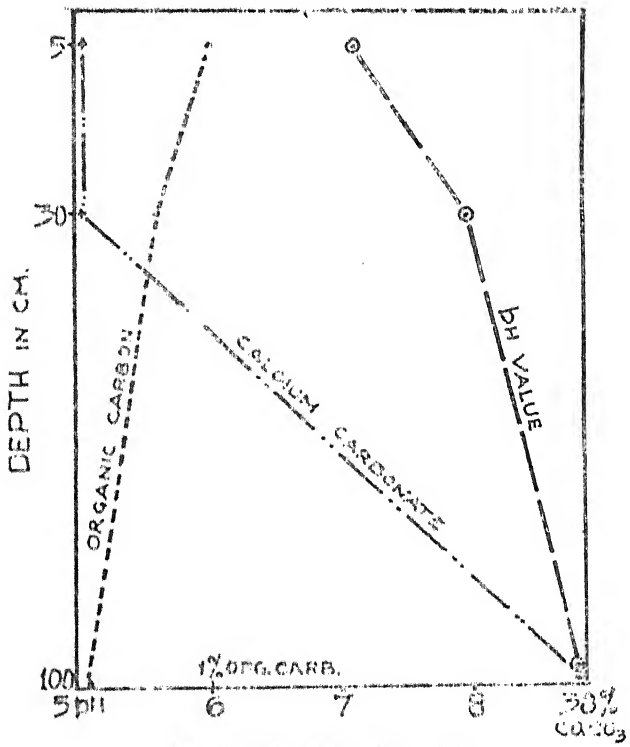

FIG. 1. GRASSLAND SOIL PROFILE.

B. SOIL PROFILES UNDER FORESTS :—

(*i*) *Sal* (*Shorea robusta*) M. P. quality I.

PIT—1.

Locality—Karka at Risgaon range of South Raipur division.

Geology—Alluvium, plains.

A_{oo}—Fresh litter.

Top 10 cm.—Brownish and sandy.

PIT—2

Locality—Machkot at East Jagdalpur range of East Baster division.

Geology—Cuddapah, mainly sedimentary limestone, shales and metamorphosed quartzites and slates.

A_{oo} —Fresh litter

Top 10 cm.—Reddish brown and sandy.

Vegetation—Sal (*Shorea robusta*) dominating.

PIT—1

Month of sampling—March.

No.	Depth of sampling	pH value	Organic Carbon in gm. % of dry wt.	Total nitrogen in gm. % of dry wt.	Exchangeable Ca in gm. % of dry wt.	Exchangeable Fe in micrograms per 100 gm. of soil
1	5 cm.	5·40	2·124	0·01848	0·090	7,200·0
2	15 cm.	5·30	0·171	0·02926	0·096	26,287·5
3	45 cm.	6·25	0·070	0·02156	0·079	19,875·0
4	90 cm.	6·25	0·294	0·01694	0·090	3,123·7

PIT—2

1	5 cm.	5·05	1·680	0·00150	0·065	1,616·2
2	15 cm.	5·60	0·573	0·00462	0·090	27,187·5
3	45 cm.	5·60	0·096	0·00308	0·036	57·8
4	90 cm.	6·30	0·219	0·00231	0·060	41·9

Profiles under Sal forests are slightly acidic to neutral, and the pH shows an increase with depth. Iron increases in the upper soils followed by a sharp decline. The soils under Sal quality I forests may be described to have undergone leaching and thus attained some degree of maturity (see fig. 2). On the basis of chemical characters the profiles may be divided into 4 layers :—

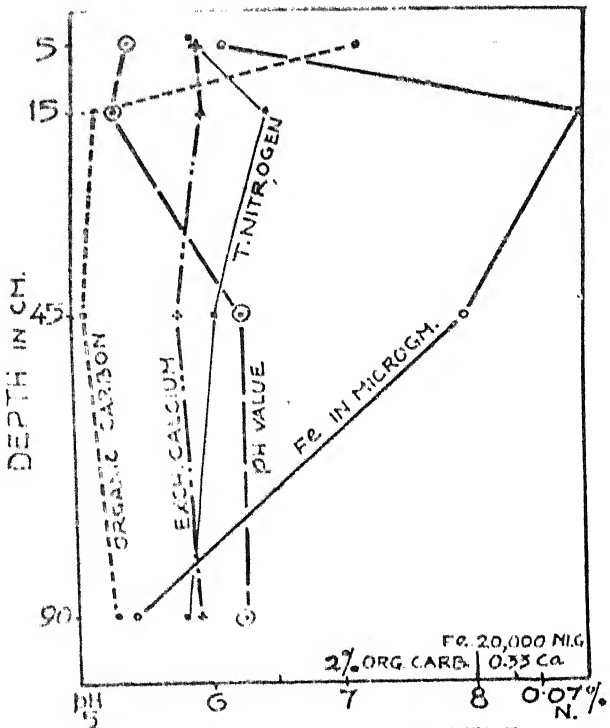

FIG. 2. SAL SOIL-PROFILE

1. Upper 5 cm. after removing fresh litter. This is probably under decomposition.

2. Next about 15 cm. This zone, as a consequence of decomposition, has become richer in bases. Here both calcium and nitrogen are more.

3. Next about 30 cm. Due to leaching, probably, this layer is poorer in bases and rich in iron. Perhaps leaching is under 'laterisation' process.

4. Lower than about 50 cm. In which concentration of elements has started and thus shows increase in calcium and decrease in iron.

(*ii*) Under teak (*Tectona grandis*) forests.

Locality — Badwani
Geology — Deccan trap (basalt).
Vegetation — Teak dominating.
A_{00} — Fresh litter
Top 10 cm. — Brownish.

Month of sampling-March. (All figures in % of dry wt.)

No.	Depth of sampling	pH value	Organic Carbon in gm.	Total nitrogen in gm.	Exchangeable Ca in gm.	Exchangeable Fe in microgm.
1.	5 cm.	6·4	3·21	0·042	0·30	50·0
2.	30 cm.	5·8	1·91	0·040	0·23	157·5
3.	60 cm.	5·5	1·57	0·070	0·22	185·0

The profile is near neutral and rich in bases in comparison to Sal profiles (see fig. 3).

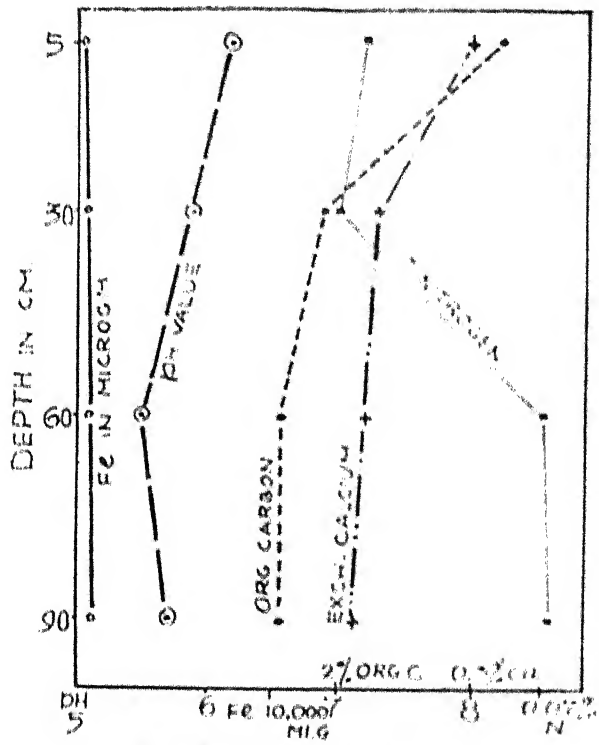

FIG. 3. TEAK SOIL PROFILE.

(iii) Under Miscellaneous forests :

PH—1.

Locality—Shahgarh, plain.

Geology—Sandstones.

Vegetation—*Anogeissus latifolia*, Teak and *Diospyros melanoxylon*.

A_{oo}—Fresh litter.

Top 10 cm.—Reddish brown, and sandy.

PIT—2

Locality—Napanagar ; almost plain.

Geology—Deccan trap (basalt).

Vegetation—*Anogeissus latifolia* and *Boswellia serrata*.

A_{co}—Fresh litter.

Top 10 cm.—Brown loamy.

PIT—1

Month of Sampling-March (In % of dry wt.)

No.	Depth of	pH value	Organic Carbon in gm. %	Total nitrogen in gm. %	Exchangeable Ca in gm. %	Exchangeable Fe in microgm.
1.	5 cm.	7·05	1·68	0·020160	0·13	40·0
2.	30 cm.	6·40	2·32	0·006300	0·10	95·5
3.	60 cm.	6·60	0·54	0·006063	0·09	540·0
4.	90 cm.	6·70	0·18	0·006300	0·09	60·0

PIT—2

1.	5 cm.	6·05	3·23	0·007700	0·27	1,450·0
2.	30 cm.	6·70	1·78	0·006100	0·17	56·5
3.	60 cm.	6·50	2·18	0·006100	0·33	1,260·0

The profiles are neutral to slightly alkaline with varying amounts of calcium depending upon the parent rock and the degree of leaching (see fig. 4).

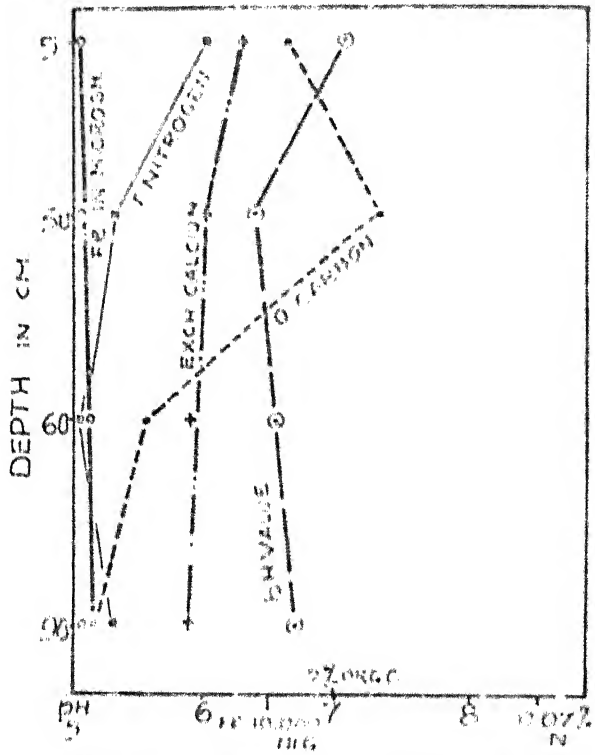

FIG 4. MISC FOREST SOIL PROFILE.

Thus a clear distinction is obtained in the p files under different types of vegetation. Of grasslands the soils are rich in minerals with lime concentration at the deeper depths. Miscellaneous forests have fresh and base poor to immature and base rich soils. With further leaching under teak floor the soil becomes poorer in minerals. Finally, under humid climate and Sal growth extensive leaching makes the profile slightly acidic to neutral and poor in bases.

Based on degree of leaching the following soil types may be recognised in Madhya Pradesh :—

I. SKELETAL AND YOUNG SOILS—are transported soils or freshly weathered mass and have not undergone any downward movement of minerals.

II. When the surface is covered with vegetation they tend to become leached to various degrees depending upon the climate, type of vegetation and topography. It proceeds differently under grasslands and forests :—

(1) LIME SATURATED—On low lying lands and under grasslands in wetter zones of the state chemical leaching is probably of calcification type. Soils have pH above 6·5.

(2) Under forests :—

(*a*) LIME RICH—Under open miscellaneous deciduous forests leaching is less and the profile is rich in calcium depending upon the parent rock.

(*b*) LIME MODERATE—With slightly more of leaching lime becomes only in moderate doses. The profile is neutral and not poor in bases. Effect of parent rock may still be pronounced.

(*c*) LIME DEFICIENT—With further leaching under humid climate and vegetation with litter not rich in bases the soil becomes acidic and poor in bases. Upper soils have accumulation of iron. This is the status of soils under low quality Sal forests.

(*d*) BASE DEFICIENT—Under best quality Sal forests, with time, the soil is further leached and becomes base deficient.

CONCEPT OF SOIL MATURATION

Vertical zonality bringing about maturation of soil has not been observed in India so far. The present study claims to observe that at least some Madhya Pradesh soils have attained certain degree of maturity. However, they do not show a marked vertical colour zonality. They are also not 'acid' ones. Having known this interest arises to evaluate the maturation process at work in the soils.

Maturation of the type of temperate zones may not be found in India since the climate is so markedly different. In temperate climate due to low temperature and restricted precipitation profiles show a clear zonation. Both physical and chemical changes occur in such soils. However, under tropical climate of India physical changes like effect of frost, etc., usually do not occur, at least in Madhya Pradesh. Except in the initial fragmentation of sun exposed rocks the main weathering agent appears to be rain water and substances dissolved in it. At higher tropical temperature and abundant water hydrolysis would be very rapid and the only physical weathering would be transportation. Indian soils are very ancient ones in comparison to Europian soils which date back only as far as last glacial age. It may also be added that maturation will proceed only at places where precipitation is more than evaporation and where the soil will not get desiccated to start back-accumulation of bases by capillary rise.

Maturation under grasslands is probably like 'calcification'. Under forests, at least in this state, maturation will probably be 'laterisation'. Laterisation essentially brings about leaching of bases like calcium and making the upper soil neutral to acidic. This favours removal of silica, and iron and aluminium are left behind. Sal soils appear to be of this nature. It may be pointed out that maturation in Indian soils should be judged by its base status and not by visual zonal colour distinction. Absence of colour distinction in Indian soil profile is probably due to heavy precipitation resulting in infiltration of leachate to greater depths. Concentration zone is usually deep seated in Indian 'Mature' soils.

Misra and Puri (1957) have lucidly differentiated between 'laterite soils', 'lateritic soils' and 'red soils' of India. The same are presented below :—

LATERITE SOIL	LATERITIC SOIL	RED SOIL
1. Largely hydrated sequioxides of iron and alumino with free silica, in the form of quartz grains.	1. Same	1. Mainly siliceous and aluminous and contain free quartz and sand.
2. Phosphoric acid & titanium present, but alkalies and alkaline earth absent, especially calcium and magnesium salts.	2. Other bases are poor except lime.	2. Poor in lime, magnesium phosphorous but rich in potash Their base exchange capacity for calcium, etc., is generally low.
3. Acidic with little or no humus.	3. Same	3. Same
4. SiO_2/Al_2O_3 ratio is low in a mature sample.	4. The ratio is high.	4. ———
5. Due to intense leaching are infertile.	5. ———	5. Deficient in soluble bases with an accumulation at lower depths.
6. Colloids essentially present.	6. Colloids not largely present.	6. ———

The characters of these soils largely point to the existence of maturation. With some reservation it may be said that the above three cited soils appear only to be three phases in the process of 'laterisation'. All these soils are commonly rich in oxides of iron and aluminium (hydrated) and poor in bases.

Further, it may be noted that since the washed soils under Sal are similar even though on different geological formations, parent rock does not appear to be the principal factor in soil maturation as hitherto conceived. It appears that for soil maturation 'climo-vegetational' factor is of paramount importance. It may also be pointed out that total annual precipitation alone will be insufficient to delimit areas showing soil maturation. Covering vegetation, existence of high humidity and spread of rainfall should also be considered in evaluating the status of soils.

SUMMARY

1. "The soils of India are essentially mineral soils... —without a characteristic profile development."—Misra and Puri (1957). In the present paper an attempt has been made to gauge the validity of this statement with reference to Madhya Pradesh soils.

2. It has been observed by profile studies that at least some Madhya Pradesh soils have attained certain degree of maturation.

3. It is argued that maturation of the type of temparate zones may not be found in Indian climate. In India soil maturation will have its own pattern. Under grasslands it is probably of 'calcification type' and 'laterisation' appears to occur in forest soils. Maturation will only be at those places where evaporation does not completely desiccate the upper soil to start back-accumulation of bases by capillary rise. It has been further discussed that total annual preciptation alone will be insufficient to delimit such areas. Type of vegetation, existence of high humidity and spread of rainfall should also be considered in evaluating the status of soils.

4. Soil maturity has been judged by the base status of the profile and not by visual distinction of the soil layers.

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REFERENCES

Misra, R. and G. S. Puri, 1957. Indian Manual of Plants Ecology. The English Book Depot, Poona-1

Pandeya, S. C., 1953. Ecological studies of glasslands of Sagar. Ph. D. thesis; University of Saugar.

Piper, C. S., 1947. Soil and Plant analysis. University of Adelaide, Adelaide.

BOTANICAL EXPLORATION OF KERALA

By

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Botanical Survey of India, Poona

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INTRODUCTION

In continuation of the botanical explorations of the humid Tropic regions of North Kanara by Puri and Arora (1959) and the District of Belgaum, Agumbe and Shimoga of Mysore (Ahuja, 1959) and Coorg by Puri and Arora (1959), the Western Circle of the Botanical Survey of India has been carrying on exploration of the state of Kerala also, for the last three years.

Previous workers like Rama Rau (1914) and Bourdillon (1937), in this area, have already contributed to the floristic studies of the then princely states of Travancore-Cochin. Rama Rau in his publication on the Flowering Plants of Travancore gives only the names of the species and their usage but does not describe the other characters of the species mentioned, which are rather important factors in floristic studies. Bourdillon has dealt with the Forest trees of Travancore with general descriptions of characters of species but gives no account of the herbs or shrubs. Thus, to facilitate the study of botany and vegetation, it was considered necessary that complete floristic studies of herbs, shrubs and trees of the state, with description, covering all the areas, specially unexplored parts, be made which would be of immense value to the inhabitants of this state whose main activities are concerned with plantation of one or the other sort.

The present work of the authors describes the general types of vegetations found in the Kerala state. It is the first step towards an attempt to study the complete flora and vegetation of the Kerala state, which will help in future to make a complete flora of the state.

A number of exploration tours were taken. In the year 1957, Kurachikella, Trivandrum, Munnar, Peermade, Vendiperiyar, Kumpli, Deviculam, Chalakadi, Vadaikal, Chilakud, and Poringal were visited and several thousand plant specimens were collected. Similarly, in the year 1958, the places visited for collection work were Nilambur, Aruvacoda, Sappal Forest area, Olavakkot, Walyar forest area, Kanjkode, Munthakoda, Malampuzha, Ernakulam, Vettilapara, Thekkadi, Puthupalli, Peermade, Quilon, Punalur, Edamon, Mukkadarn, Chunkankadai, Muttakaru, Karakulam and Ponmudi Hills and Trivandrum. A short trip to Trivandrum and neighbouring areas was again taken in October 1958.

During the visit to these places, it has been observed that in a number of areas forests are being cleared up for the rehabilitation of ex service men or for cultivation of food or cash crops, with the result that an interesting part of the natural flora is being destroyed. The Kerala State is full of plantations of tea, coffee, rubber, cardamum in the hills and cocoanut, tapioca, paddy etc. in valleys. However, there are still many places such as Silent Valley and Nilambur Valley where virgin forests, extremely rich in plants, exist. It is extremely difficult to carry out the

exploration work in such forests since these are very thick and inaccessible, with a large number of wild animals, such as elephants and cobras dwelling in them. There is also lack of transport and other facilities which add to the already existing difficulties and hardships encountered especially during the monsoon time, when leaches and mosquitoes can keep out of the forest any daring botanist. Thus, in the absence of these facilities, post monsoonic periods are the only time suitable when collections could be made with ease.

Nevertheless, attempts have been made to visit the areas in all the seasons of the year, and large number of plant specimens have been collected out of which 525 plant specimens have been identified so far. The identification work is still in progress.

HABITAT FEATURES OF THE AREA STUDIED

The State of Kerala lies approximately between the latitudes 8° 2'-13° N and longitudes 75° E-77° 5' E. A large portion of the State comprises of the coastal plain areas and high mountains of the Western Ghats. The topography of the State varies from the plain coastal areas to the hilly tracts in the inner most parts of the State, and the mountainous configuration of the most part of the country varies in elevation from sea-level to as high as 8837 feet or so.

Geologically, the State of Kerala has got the following three different types of formations :—

1. *Recent Deposits*

   Which are generally found along the coastal areas of the State.

2. *Older Alluvium-Laterite.*

   Which are found slightly into the interior side of the State. Here the soils are generally red in colour.

3. *Unclassified Crystalline-Gneissis etc.*

   Major portions of the State are formed of unclassified crystalline Gneiss formations in mountains of the Western Ghats.

Climatically, the State comes under the influence of both the South-West and North-East Monsoons. The South-West Monsoon starts from the month of May and continues up to August. The North-East Monsoon begins in the month of October and lasts for about two months or so. March and April are the hottest months of the year. In the hotter parts of the state, the temperature in the dry weather well rises above 100°F. In general, the state has got the tropical type of climate, with the rainfall ranging from 60 inches to as high as 300 inches at a place like Pettimudi. Its tropical climate, heavy rainfall and the mountainous configuration of the most part of the area have contributed towards the richness and diversity of its flora.

FEATURES OF VEGETATION

The following main types of tropical vegetation are met with :—

(*a*) Wet Evergreen Forests

(*b*) Semi-evergreen Forests

(*c*) Moist deciduous Forests

(*d*) Dry deciduous Forests

(*e*) Grasslands (in patches)

In the wet evergreen forest the plant species like *Mesua ferrea, Callophyllum tomentosum, Artocarpus* sp., *Xanthophyllum flavescens, Cinnamomum zeylanicum, Mangifera indica, Pterospermum, reticulatum, Actinodaphne hookerii, Diospyros microphylla, Holigarna arnottiana, Memecylon edule, Mimusops elengii, Bischofia javanica, Cedrela toona, Eugenia jambolana, Eugenia arnotiana, Hopea parviflora, Vateria indica, Trewia nuliflora, Salmalia malabarica* etc. are found. These evergreen forests have a thick and dense canopy with the ground flora, rather meagre. The trees are generally very high. For example, in the Palghat area, in the evergreen forest, the tree height reaches to about 30-40 meters. Among the tall trees there, *Pterospermum acerifolium* is very prominant, its associates being *Grewia tiliaefolia, Ficus* sp., *Bischofia javanica, Evodia roxburghii, Limonia* sp., *Garollia* sp., *Macaranga peltata, Trema orientalis* and several others.

The plants generally found in the semi-evergreen types of vegetation are typical of both the evergreen and moist deciduous types. They are *Adina cordifolia, Salmalia malabarica, Syzyguim* spp. *Hopea parviflora, Mangifera indica, Cedrela toona, Lagerstroemia lanceolata, Lagerstroemia speciosa, Vitex altissima, Cinnamomum zeylanicum, Mallotus philippinensis, Xanthophyllum flavescens, Terminalia tomentosa, Terminalia paniculata, Dalbergia* sp., *Morinda* sp., *Wrightia tinctoria, Callophyllum tomentosum, Mitragyna parviflora, Pterospermum* sp., *Elaeagnus latifolia* etc. At the Doni area, about 14 miles from Olavakkot, in the semi-evergreen forest, the community of *Terminalia paniculata* is found. It has a very few associates. The trees are not tall. The maximum height of Terminalia tree is about 7-8 meters.

In the moist deciduous forests, one comes across the plant species like *Terminalia tomentosa, Terminalia paniculata, Pterocarpus marsupium, Albizzia procera, Alstonia scholaris, Cedrela toona, Terminalia bellerica, Bridelia retusa, Careya arborea, Dillenia pentagyna, Anogeissus latifolia, Gallicarpa lanata, Vitex altissima, Salmalia malabarica, Grewia tiliaefolia, Cassia fistula, Gmelina arborea, Strychnos nux-vomica, Mitragyna parviflora, Xylia xylocarpa, Sterculia* sp. etc., are found. The species like *Sterculia*, in the moist deciduous forest at Vettilapara, an area 14 miles towards the North-East of Chelakudi, is found to be of fairly good height. The other species found growing along with *Sterculia* were of *Lagerstroemia speciosa, Dipterocarpus* sp., and *Strychnos nux vomica.*

In the Kerala State Teak plantations have been raised extensively in Nilambur Valley. The following three types are found :—

1. Teak (cultivated) dominant community.
2. Teak (cultivated) Bamboo community.
3. *Xylia xylocarpa* community-which is a natural community growing on lateritic soil.

The Teak dominated community is plantations, in which there are a few associates of Teak. The most dominant of these is *Mallotus philippinensis*, growing quite common. The other associates are *Terminalia paniculata, Melochia umbellata, Trewia nuliflora, Macranga peltata* etc.

The Teak-Bamboo community is similar to the one described above excepting that the teak here is mainly associated with *Bambusa arundinaceae* and *Ochlandra* sp., which grow forming tufts. The other associates in the community are *Mallotus* sp. *Macranga peltata Randia dumetorum, Dalbergia* sp , *Cassia fistula, Ailanthus malabarica* etc.

Teak-*xylia* community is present in patches only. Here the main associates of teak are *Xylia* sp., *Mallotus* sp., *Macranga* sp., *Lagerstroemia parviflora, Randia* sp.,

Photo 1. A view of an evergreen forest at Ponmudi, showing a tree of *Albizzia* sp. in the foreground. Some of the other species growing in the forest are of *Pterospermum acerifolium*, *Ficus asperrima*, *Erythrina indica*, *Vitex altissima* etc.

Photo 2. A view of evergreen forest at Tenmalai showing the plantation of *Hevea brasiliensis* at the base of the hill. In the foreground is the shrubby layer of *Eupatorium* sp., which is very abundant.

Photo 1. A close-up of *Dendrobium* sp., an epiphytic orchid in flower and fruit, in the evergreen forest of Ponmudi.

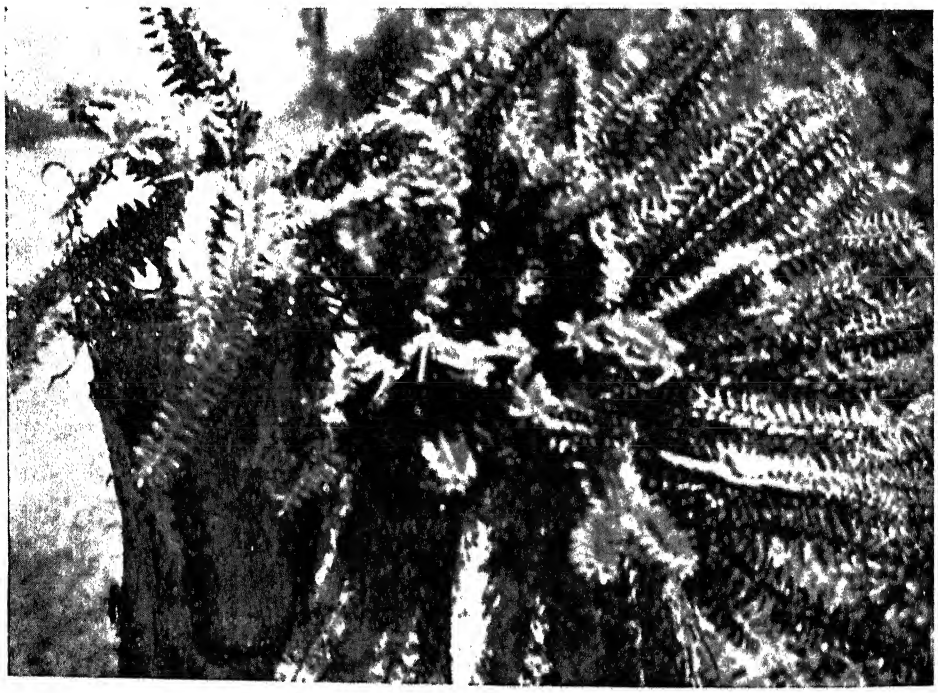

Photo 2. A close-up of *Lycopodium* sp. an epiphytic plant, growing on the branches of trees, in the evergreen forest at Ponmudi.

Pterospermum acerifolium, *Pongamia glabra*, *Schleichera trijuga* etc. The last two are found near the river bank only.

The *Xylia xylocarpa* community is mostly seen in the laterite plains. Here the main associates of *Xylia* are *Anacardium occidentale*, and *Artocarpus hirsuta*. Occasionally, bamboos are also seen associated with *Xylia*. The other tree associates are *Terminalia paniculata*, *Terminalia bellerica*, *Mallotus* sp., *Lagerstroemia speciosa*, etc.

Under the dry deciduous forest, *Acacia leucophloea*, *Albizzia* spp. *Salmalia malabarica*, *Careya arborea*, *Chukrasia tabularis*, *Gmelina arborea*, *Grewia tiliaefolia*, *Melia azadirachta*, *Santalum album*, *Zizyphus* sp., *Cassia fistula*, *Pterocarpus marsupium*, *Phyllanthus emblica*, *Tectona grandis*, *Terminalia chebula*, *Wrightia tinctoria*, *Olea dioica*, *Holarrhena antidysenterica* *Gallicarpa lanata*, *Clerodendron infortunatum* are found.

Grasslands in the state are found only in patches. Among the grasses *Eleusine indica*, *Anthistiria tremula*, *Aristida setacea*, *Arundinella* sp., *Eragrostis amabilis*, *Arundinella mesophylla*, *Cymbopogon citratus*, *Panicum plicatum*, *Paspalum vaginatum*, *Isachne pulchella*, *Arundinella agrostoides*, *Dactyloctenium aegyptium*, *Isachne walkeri*, *Ischaemum molle* are found generally on the rocky areas and on the hilly slopes.

Arundinella tenella, *Eragrostis superba*, *Heteropogon ritchei*, *Coix lachryma-jobi*, *Ischaemum aristatum*, *Themeda quadrivalves* etc., are some of the grasses growing in moist areas.

Grasses like *Aristida hystrix*, *Anthistiria cymbaria*, *Eleusine indica*, *Eragrostis unioloides*, *Aristida funiculata*, *Ochlandra travancorica*, *Pennisetum alopecuros*, *Pennisetum cenchroides*, *Pennisetum orientale*, *Dichanthium annulatum*, *Oplismanus* sp., *Digitaria* sp., and *Arthraxon* sp., etc. are found growing on the open areas and along the road sides in the forest clearings.

In the evergreen and semi-evergreen forests, a number of orchids are found. Among these *Aerides odoratum*, *Bulbophyllum nilgherrense*, *Dendrobium herbaceum*, *Dendrobium macraei*, *Eria pauciflora*, *Liparis longipes*, *Pholidota imbricata*, *Aerides maculosum*, *Oberonia brunoniana*, *Aerides crispum*, *Dendrobium picrardi*, *Luisia teretifolium*, *Saccolabium viridiflorum* are some of the epiphytes on different trees in these forests.

During the visits to the different areas and forests, several herbs and shrubs have been collected. These are *Euphorbia hypericifolia*, *Mollugo pentaphylla*, *Anisomeles heyneana*, *Abutilon indicum*, *Cassia callosa*, *Carissa macrophylla*, *Antidesma menasu*, *Croton reticulatus*, *Calycopteris floribunda*, *Tabernaemontana heyneana*, *Leea sambucina*, *Leea aspera*, *Vitex negundo*, *Glycosmis pentaphylla*, *Cassia tora*, *Gallicarpa lanata*, *Mussaenda frondosa*, *Tridax procumbens*, *Zizyphus* sp., *Lantana camara*, *Solanum xanthocarpum*, *Solanum torvum*, *Psychotria* sp., *Rauwolfia* sp., *Eupatorium* sp., and several other herbs belonging to the families of Cyperaceae, Zingiberaceae etc.

Under the forests a good number of Lianas, climbers and creepers are also found, namely the species of *Cocculus macrocarpa*, *Anamirta cocculus*, *Hemidesmus indicus*, *Cocculus villosus*, *Vitis lanceolaria*, *Vitis gigantea*, *Vitis tenuifolia*, *Vitis latifolia*, *Vitis reticulata*, *Cryptolepis buchanani*, *Stephania hernandifolia*, *Smilax zeylanica*, *Piper hookerii*, *Piper nigrum*, *Piper sylvestre*, *Jasminum flexile*, *Jasminum malabaricum*, *Jasminum rottlerianum*, *Strychnos beddomei*, *Modecca wightiana*, *Passiflora foetida*, *Cardiospermum halicacabum*, *Asparagus racemosus*, *Abrus pulchellus*, *Phaseolus trinervius*, *Shuteria vestita*, *Dioscorea daemona*, *Dioscorea sativa* etc.

Besides, a number of Filicales are also found. Some of them are epiphytic and some non-epiphytic in nature. These plants are generally found under shady and moist conditions. Among the epiphytic ferns *Drynaria* sp., *Pleopeltes* sp., *Thamnopteris nidus* etc. are found, where as *Nephrodium* sp., *Lygodium flexiosum*, *Angiopteris* sp., *Stenoloma chinensis*, *Pteris quadriaurita*, *Blechnum orientale*, *Davalia* sp., are the forms which are non-epiphytic in nature and are generally found near the moist and shady habitat.

Further work on the vegetation of the Kerala State is in progress and a complete list of plants will be published elsewhere.

We take the opportunity to express our gratitude to Dr. J. C. Sen Gupta, Chief Botanist, Botanical Survey of India, for his abiding interest in our work. The Chief Conservator of Forests, Kerala, and his various officers have greatly helped us in field and exploration work and we are grateful to them.

REFERENCES

1. Ahuja, B. S. 1959. Studies in the Vegetation of Deccan Trap Country-II. Plants of Belgaum and Kolapur Area. *Proc. Ind. Sci. Cong.* Part III, pp. 309.

2. Blatter, E. and D'Almeida J. F. 1922. The Ferns of Bombay. D. B. Taraporevala Sons and Co., Bombay.

3. Bourdillon, T. F. 1937. The Forest Trees of Travancore.

4. Cooke, T. 1903-1908. The Flora of the Presidency of Bombay, Vol. I-II.

5. Hooker, J. D. 1872-1894. The Flora of British India. Vol. I-VII. L. Reeve and Co., London.

6. Misra, R. and Puri, G. S. 1954. Indian Manual of Plant Ecology. English Book Depot, Poona-1.

7. Puri, G. S. and Arora, R. K. 1959. The Flora of North Kanara, Western Ghats, India. *Proc. Ind. Sci. Cong.* Part III, (p. 294).

8. Puri, G. S. and Arora, R. K. 1959. Studies On the vegetation of Coorg, Western Ghats, India. *Proc. Ind. Sci. Cong.* Part III, (p. 305).

9. Rama Rau, M. 1914. Flowering Plants of Travancore. Government Press, Trivandrum.

SEASONAL VARIATIONS IN THE LENGTH AND WEIGHT OF THE OVARIES OF MYSTUS SEENGHALA (SYKES) AND WALLAGO ATTU (BLOCH)

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INTRODUCTION

The study of the seasonal changes in the length and weight of the ovaries of two fresh water fishes, *Mystus seenghala* (*Sykes*) and *Wallago attu* (*Bloch*) was undertaken as little research of this type has been carried out on such fishes. On the basis of this study an attempt is also made to draw some conclusions regarding the spawning season of the two species.

The work was carried in the Research laboratory of the Allahabad University.

MATERIAL AND TECHNIQUE

The ovaries were collected from adult fishes, caught from the river Jamuna at Allahabad, United Provinces, twice or thrice a week for one complete year. The length and weight of the fishes from which ovaries were taken were recorded in inches and grams together with the respective dates of collection.

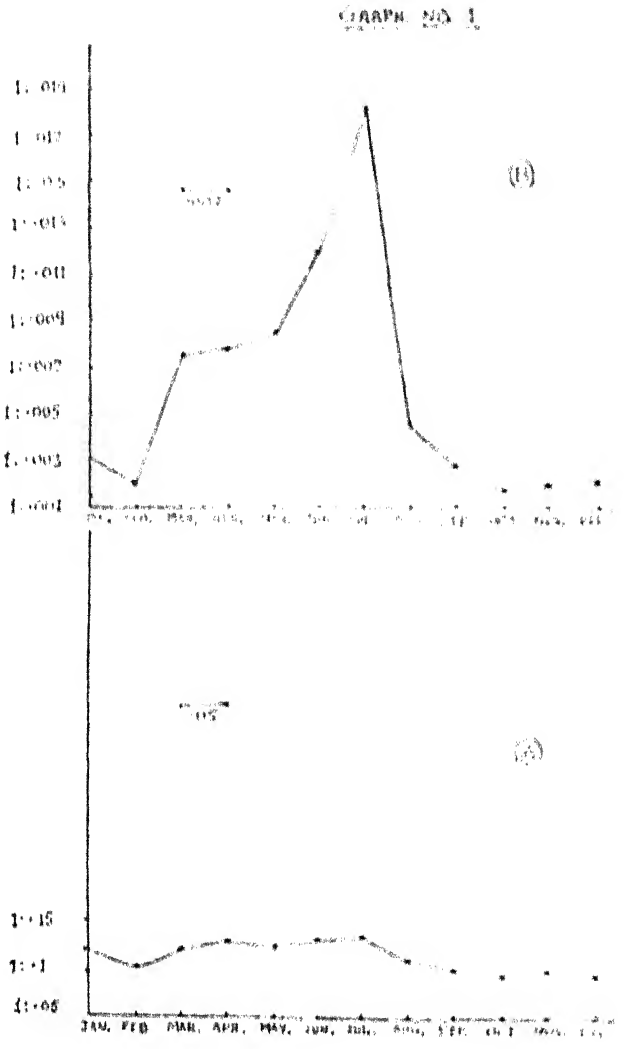
The ovaries were fixed in 5% formalin. Their length and weight were noted in inches and grams respectively.

To minimise errors in the study of length and weight of the ovaries, which might have resulted from fluctuations in the size of fishes from which they were collected, the following procedure was adopted :—

For each date of collection, the length of the fish and that of its ovary being known the ratio between the two was calculated by dividing the latter by the former. In this way a ratio was determined for each collection of a month and then the average ratio was worked out for the entire month. Likewise, average ratios were obtained for all the months in a year.

The same procedure was adopted for the study of the weight of the ovaries.

The variations in these ratios are discussed for each fish separately.



Graph 1: *Mystus seenghala*

(*A*) Graph showing variations in the average ratio between the length of the fish and its ovary in the different months of a year.

(*B*) Graph showing variations in the average ratio between the weight of the fish and its ovary in the different months of a year.

Mystus seenghala.

(*A*) *Variations in the length of the ovary* —

The average ratio between the length of the fish and that of its ovary in different months of a year was as follows :—

Jan.	Feb.	March	April	May	June
1 : ·12	1 : ·10	1 : ·12	1 : ·132	1 : ·13	1 : ·132
July	August	September	October	November	December
1 : ·135	1 : ·11	1 : ·104	1 : ·102	1 : ·108	1 : ·101

From a perusal of the above data, it is apparent that this ratio varies from month to month in a year. The variations in this ratio are plotted in graph 1 (A).

(*B*) *Variations in the weight of the ovaries.*

The average ratio between the weight of the fish and that of its ovary in different months of a year was as under—

January	February	March	April	May	June
1 : ·003	1 : ·002	1 : ·0075	1 : ·0078	1 : ·0084	1 : ·0120
July	August	September	October	November	December
1 : ·0183	1 : ·0045	1 : ·0027	1 : ·0018	1 : ·0019	1 : ·002

The changes in this ratio are represented graphically in the graph 1 (*B*)

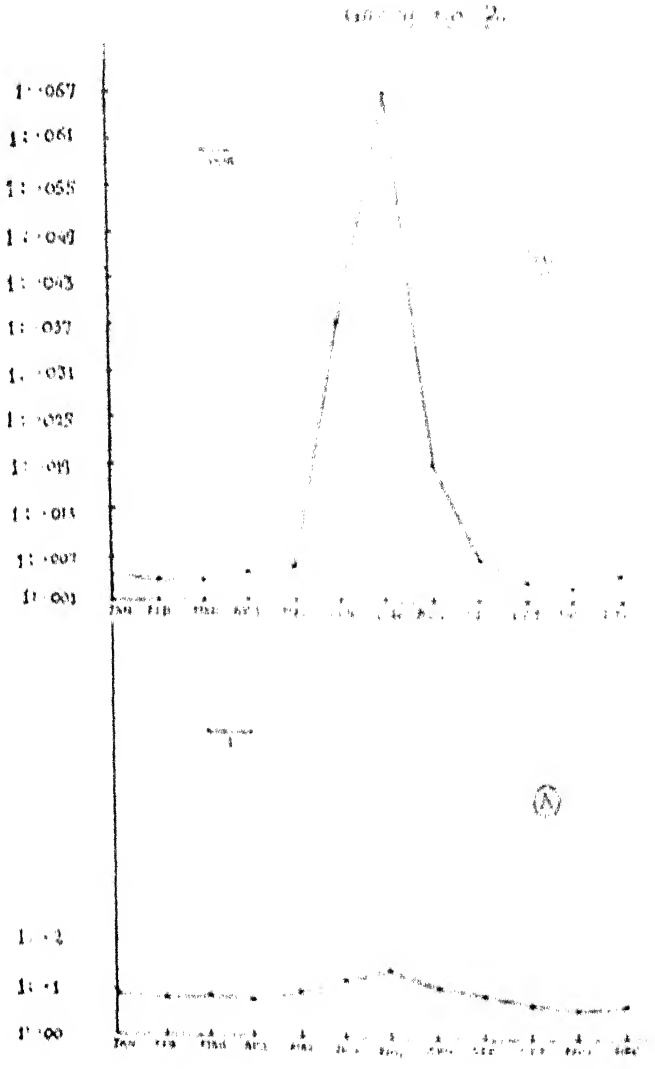
Wallago attu.

(*a*) *Variations in the length of the ovary.*

The average ratio between the length of the fish and the length of ovary in the different months in a year is recorded below :—

January	February	March	April	May	June
1 : ·086	1 : ·082	1 : ·086	1 : ·03	1 : ·09	1 : ·128
July	August	September	October	November	December
1 : ·142	1 : ·11	1 : ·096	1 : ·076	1 : ·072	1 : ·075

The variations in this ratio, are portrayed in the graph 2 (*d*).



Graph 2 : *Wallago attu*

(*A*) Graph showing the changes in the average ratio of the length of the fish and its ovary in the different months of a year.

(*B*) Graph showing the changes in the average ratio of the weight of the fish and its ovary in the different months of a year.

(*b*) *Variations in the weight of the ovary.*

The average ratio between the weight of the fish and that of its ovary in different months in a year is as follows :—

January	February	March	April	May	June
1 : ·054	1 : ·0336	1 : ·0037	1 : ·0046	1 : ·0054	1 : ·0363
July	August	September	October	November	December
1 : ·0665	1 : ·0185	1 : ·0069	1 : ·0036	1 : ·0029	1 : ·0041

The variations of this ratio are graphically represented in graph 2 (*B*).

DISCUSSION

The study of the data and graphs obtained for the lengths and weights of the ovaries of the two fishes *Mystus seenghala* and *Wallago attu*, shows that in general they respond almost in a similar fashion to the change of months in a year. By similarity is meant that the rise and fall in the ratio of length of the ovary are followed, in general, by a rise and fall in the ratio of its weight. Secondly, a perusal of the data and graphs shows that in both the fishes the variations are more pronounced in the case of the weight of the ovary than that of its length.

This study furthermore, reveals that there is an almost gradual attainment of peak of both length and weight of the ovaries of the two fishes in the month of July, after which the period of decline begins. The period before July being thus a period of almost progressive increase in the length and weight of the ovaries, can safely be regarded as the prespawning period. The graphs and data show that in the month of August the ovary after a period of gradual growth in its length and weight records a sudden fall. It is, therefore, inferred that the spawning might be taking place between July and August, but any such hypothesis can only be tentative unless the duration of spawning is subjected to a detailed study in the natural habitat of the two species. But as the peak of the length and weight of the ovaries of both the fishes, is attained only once in a year, the two fishes *Mystus seenghala* and *Wallago attu* can safely be inferred to be annual breeders.

The present study supports the work of James (1946) on blue gill and large mouth bass in so far as the ovaries of both the fishes increase in their length and weight previous to spawing and decrease thereafter.

It may also be noted that the maximum ratio of the weight of the fish and that of the ovary is 1 : ·015 in the case of *Mystus* and 1 : ·066 in the case of *Wallago*. This shows that the ovary of *Mystus* forms 1·8% of the total weight of the fish, while that of *Wallago* constitutes 6·6% of the total weight of this fish. Thus the ovary of *Wallago attu* constitutes a much higher percentage of body weight of this fish than that of the ovary of *Mystus seenghala*.

SUMMARY AND CONCLUSION

1. The length and weight of the ovaries of both the fishes *Mystus seenghala* and *Wallago attu* respond to the change of months in a year.
2. The ovaries increase in length and weight prior to spawning and decrease thereafter.

3. The graphs of length and weight of the ovaries of both the fishes attain the peak only once a year and hence the fishes are inferred to be annual breeders.

4. The ovary of *Wallago attu* constitutes much higher percentage of the body weight of this fish than that of *Mystus seenghala*.

ACKNOWLEDGEMENT

The author is indebted to Dr. S. K. Dutta, D. Sc., F. N. A., Reader, Zoology Department Allahabad University, under whose guidance the work was done and to Dr. N. K. Panikkar, D. Sc., F. N. I., Fisheries Development Adviser to the Government of India, for valuable criticism and suggestions.

REFERENCE

James, M. F. 1946. Histology of gonadal changes in the blue gill *Lepomis macrochirus* Rafinesque and large mouth bass *Huro salmoides* (Lacepede). *Jour. Morph.* 79, (1), 63-86.

STUDIES ON THE GENUS *XENOPHARYNX* NICOLL, 1912 (TREMATODA: PLAGIORCHIIDAE)

By

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[Received on 4th May, 1959]

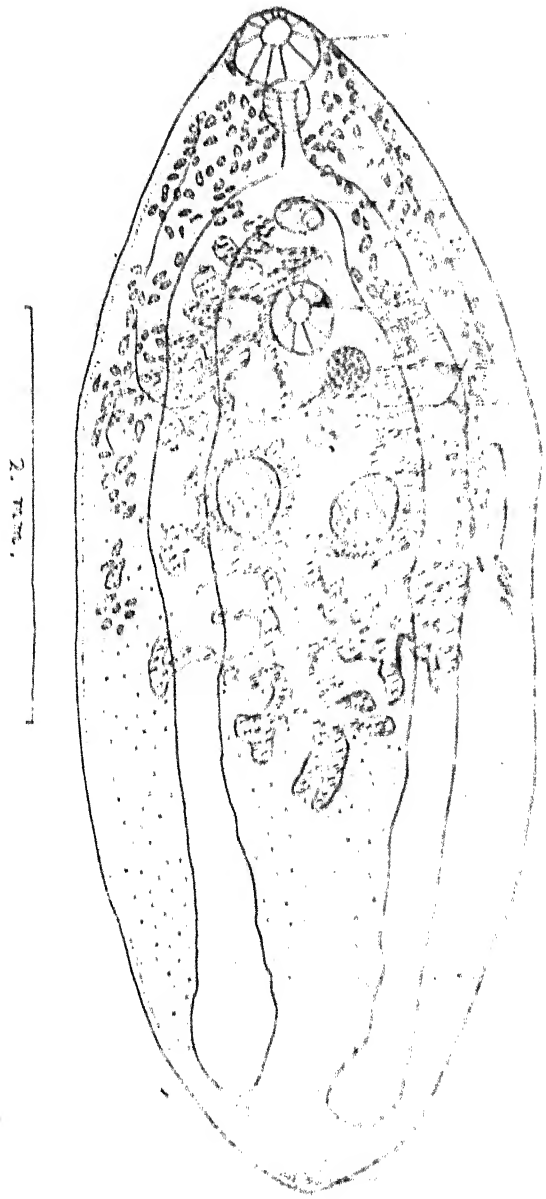
INTRODUCTION

The genus *Xenopharynx* was created by Nicoll (1912) for a trematode obtained from the gall-bladder of an Indian cobra, *Naja tripudiens*, which died in London Zoo. The type species was named as *Xenopharynx solus* and placed by him under the family Dicrocoeliidae. Khalil (1923) obtained another specimen of the trematode *Xenopharynx solus* from an Indian cobra, *Naja bungarus*, and showed that Nicoll's description as regards the position of the ovary was erroneous. He placed the genus in the sub-family Telorchinae. Bhalerao (1926) added a second species *Xenopharynx piscator* to the genus and disagreed with Khalil (1923) in putting the genus under the sub-family Telorchinae instead of Dicrocoeliidae. Poche (1926) retained the genus in the family Dicrocoeliidae. Strom (1928) described a third species, *Xenopharynx amudariensis*, from the gall bladder of *Tropidonotus tessellatus* from Turkistan and put his species under the sub-genus *Allopharynx* which he created under the genus *Xenopharynx* for the reception of his specimen. Mehra (1937) pointing out the distinctiveness of this species created a new genus *Ophiorchis* for it and placed the genus *Xenopharynx* under the sub-family Reniferinae in the family Lepodermatidae Odhner. Srivastava (1954) and Baugh (1956) described *Xenopharynx biliphaga* and *Xenopharynx indica* respectively. Sinha (1958) added two new species *Xenopharynx pyriformis* and *X. heterovitellatus* to the genus. Yamaguti (1958) has included this genus under Plagiorchiinae of the family Plagiorchiidae Ward 1917.

In this paper four new species of the genus, *Xenopharynx*, viz., *X. orientalis*, n. sp., *X. nicolli*, n. sp.; *X. mehrai*, n. sp. and *X. raipurensis* n. sp. have been described. A single specimen of each of these flukes was obtained with forms belonging to two already known species viz., *X. solus* and *X. piscator* of the genus from the gall bladder of the snakes, *Tropidonotus piscator*, about 60 of which were examined for the trematodes harbouring them.

The work was carried out in the Department of Zoology, College of Science, Raipur.

The worm is dorsoventrally flattened with rounded anterior and posterior ends. It is 5·5 mm. long and 2·4 mm. broad across the level of testes. The terminally placed oral sucker 0·35 × 0·43 mm. in size is larger than the ventral sucker. The



Text fig. 1. *Xenopharynx orientalis*, n. sp. Ventral view

ventral sucker placed at a distance of 1·28 mm. from the anterior end measures 0·35 × 0·34 mm.

The oral sucker leads by means of a small prepharynx into the muscular pharynx 0·27 × 0·22 mm. in size. The pharynx leads into the oesophagus 0·19 mm. in length and 0·11 mm. in breadth. The intestinal bifurcation lies at a distance of 0·77 mm. from the anterior end. The caeca extend upto the posterior end of the body and have swollen extremities.

The excretory pore lies at the posterior end of the body and leads into a long, tubular bladder which extends upto the testes and then divides into two cornua.

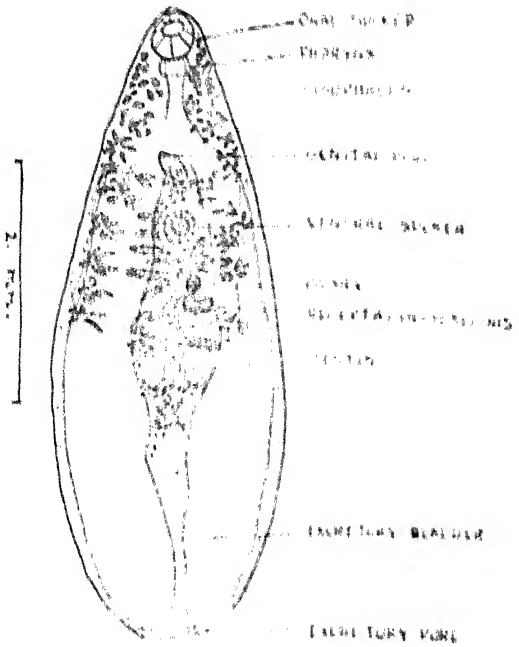
The two equal and rounded testes are placed at a distance of 2·14 mm. from the anterior end in the anterior half of the body symmetrically at one level. Each of them measures 0·39 × 0·32 mm. in size. The cirrus sac obliquely placed at the intestinal bifurcation measures 0·09 × 0·05 mm. in size. It encloses a coiled vesicula seminalis, prostate glands and an ejaculatory duct. The genital pore is situated at the intestinal bifurcation slightly to the right of the median line.

The rounded ovary 0·18 × 0·18 mm. in size lies behind the acetabulum, at a distance of 1·55 mm. from the anterior end to the left of the median line. The oviduct comes out from the inner postero-lateral margin of the ovary to receive the common vitelline duct and the duct of receptaculum seminis. The ootype lies behind the ovary. The receptaculum seminis is a transversely alongated sac placed behind the ootype and 0·3 × 0·1 mm. in size. The uterine coils overlap at many places the intestinal caeca and extend posteriorly to a level half way between the testes and the posterior end of the body.

The vitellaria exten d from the oral sucker to a level posteriorly midway between posterior level of testes and posterior extent of uterine coils.

The eggs are 0·042 × 0·021 mm. in size.

The worm is dorsoventrally flattened and measures 5·3 mm. in length and has a maximum breadth of 1·9 mm. across the level of testes. The terminally placed oral sucker is large than the ventral sucker and measures 0·38 × 0·39 mm. The ventral sucker measuring 0·29 × 0·3 mm. lies at a distance of 1·16 mm. from the anterior end. The prepharynx is small. The pharynx measures 0·17 × 0·24 mm. The oesophagus is 0·29 mm. in length and 0·69 mm. in breadth. The intestinal bifurcation lies at a distance of 0·88 mm from the anterior end. The intestinal caeca occupy most of the available space in the body and reaching the posterior end of the body their ends lie near each other.



Text Fig. 2. *Xenopharynx nicolli*, n. sp. ventral view

The excretory pore situated at the posterior end leads into a Y shaped vesicle with a long median stem extending upto testes where it divides into two short cornua.

The two rounded and unequal testes are placed symmetrically at one level in the posterior half of the body at a distance of 2·68 mm. from the anterior end. The left testis measures 0·32 × 0·36 mm. and the right is 0·3 × 0·28 mm. in size. The cirrus sac 0·28 × 0·12 mm. in size, obliquely placed at the intestinal bifurcation encloses inside it a coiled vesicula seminalis, pars prostatica and the ductus

ejaculatoricus. The genital pore is situated at the intestinal bifurcation to the right of the median line.

The rounded ovary 0·15 × 0·14 mm. in size lies behind the acetabulum at a distance of 2·08 mm. from the anterior end to the left of the median line. The receptaculum seminis 0·23 × 0·09 mm. in size is a transversely elongated sac place behind the ovary. The uterine coils are mostly intracaecal, only slightly overlapping the caeca at some places and extending posteriorly to a little behind the testes.

The vitellaria extend from the oral sucker anteriorly to a level in front of the testes posteriorly. The vitelline follicles are arranged in zones. The transverse vitelline ducts pass just behind the ovary.

The eggs are 0·036 × 0·021 mm. in size.

XENOPHARYNX MEHRAI, n. sp.

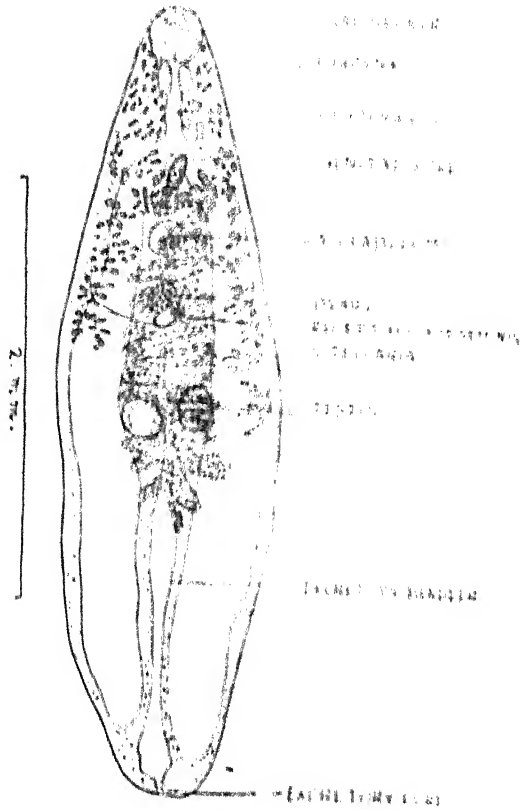
The worm is dorsoventrally flattened and measures 3·7 mm. in length and 1·23 mm. in maximum breadth across the level of testes. The oral sucker is larger than the ventral sucker and measures 0·28 × 0·28 mm. The ventral sucker lies at a distance of 1·12 mm. from the anterior end and measures 0·22 × 0·22 mm.

The prepharynx is small. The pharynx measures 0·16 × 0·16 mm. in size. It leads into the oesophagus 0·21 mm. in length and 0·11 mm. in breadth. The intestinal bifurcation lies at a distance of 0·61 mm. from the anterior end. The intestinal caeca extend upto the posterior end of the body.

The excretory pore situated at the posterior end of the body leads into a Y shaped excretory bladder which has a long median stem extending upto the testes where it divides into two cornua.

The two rounded and equal testes are placed symmetrically at one level at a distance of 1·82 mm. from the anterior end. They are placed in the middle of the body and each of them measures 0·21 × 0·21 mm. The cirrus sac is oval in shape and 0·18 × 0·07 mm. in size. It is placed vertically at the intestinal bifurcation and encloses in it a coiled vesicula seminalis, pars prostatica and ductus ejaculatorius. The genital pore is situated at the intestinal bifurcation slightly to the left of the median line.

The oval ovary 0·16 × 0·13 mm. in size lies behind the ventral sucker at a distance of 1·3 mm. from the anterior end. The receptaculum seminis is oval, 0·18 × 0·09 mm. in size and lies behind the ovary. The uterine coils are intracaecal mostly and extend posteriorly to some distance behind the testes.

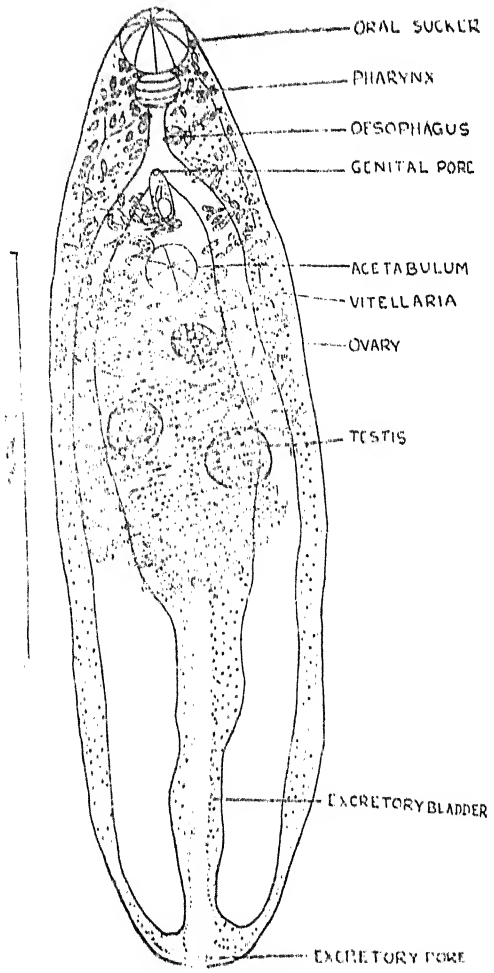


Text Fig. 3. *Xenopharynx mehrai*, n. sp. ventral view

The vitelline follicles are arranged in zones and extend anteriorly from the oral sucker. Posteriorly they extend on the right to a level midway between ovary and testes and on the left to the level of the testes. The transverse vitelline ducts pass behind the ovary and join to form the common vitelline duct.

The eggs are 0·036 × 0·021 mm. in size.

The worm is dorsoventrally flattened and measures 4·9 mm. in length and 1·4 mm. in maximum breadth across the level of testes. The oral sucker is larger than the ventral sucker and lies at the anterior end. It measures 0·32 × 0·32 mm. in size. The ventral sucker lies at a distance of 1·2 mm. from the anterior end and measures 0·24 × 0·23 mm. in size.



Text Fig. 1. *Xenopharynx raipurensis*, n. sp. Dorsal view

The oral sucker leads by means of a small prepharynx into the pharynx 0·16 × 0·21 mm. in size. The pharynx leads into the oesophagus 0·28 mm. in length and 0·08 mm. in breadth. The intestinal bifurcation lies at a distance of 0·77 mm. from the anterior end. The intestinal caeca extend upto the posterior end of the body.

The excretory pore situated at the posterior end of the body leads into the excretory bladder which is Y shaped with a long median stem extending upto the testes and there bifurcating into two cornua.

The testes subglobular in shape and intracaecal in position are obliquely set in the anterior half of the body. The anterior testis measures 0·22 × 0·28 mm. and lies at 1·9 mm. behind the anterior end. The posterior testis measures 0·29 × 0·09 mm. The cirrus sac is vertically placed at the intestinal bifurcation and measures 0·22 × 0·09 mm. It encloses a coiled vesicula seminalis, pars prostatica and the ejaculatory duct. The genital pore is medianly situated at the intestinal bifurcation.

The ovary is somewhat oval and measures 0·17 × 0·21 mm. in size. It lies at 1·51 mm. from the anterior end. The receptaculum seminis lies behind the ovary. The uterine coils are mostly intracaecal and extend posteriorly to some distance behind the testes. The vitellaria are arranged in zones and extend anteriorly from the oral sucker. Posteriorly they extend on the right to the level of the testis and on the left to a level about midway between posterior border of testes and posterior extent of uterine coils.

The eggs are 0·036 × 0·021 mm. in size.

DISCUSSION

Xenopharynx orientalis n. sp., *X. nicolli*, n. sp. and *X. mehrai*, n. sp. differ from all the known species of the genus in having the testes symmetrically placed at one level. Amongst themselves they differ in the posterior extent of vitellaria and the position of the testes. In *X. orientalis*, n. sp. the vitellaria extend upto a level midway between the posterior extent of the uterine coils and the posterior border of testes which are equal in size and placed in the anterior half of the body. In *X. nicolli*, n. sp. the vitelloria extend upto a level in front of the testes which are unequal in size and placed in the posterior half of the body. In *X. mehrai*, n. sp. the vitellaria are uneven in their posterior extent, the testes are equal in size and placed in the middle of the body.

Xenopharynx raipurensis, n. sp. resembles *X. fissiformis* in having the testes only slightly obliquely set but differs from it in the posterior extent of vitellaria, the position of the testes which are placed in the anterior half of the body and the relative size of suckers.

In the genus *Xenopharynx* the testes are diagonal but in *X. orientalis*, n. sp., *X. nicolli*, n. sp. and *X. mehrai*, n. sp. the testes are opposite which requires the elaboration of this character in the diagnosis of the genus.

Thus the genus *Xenopharynx* includes only ten species so far. They are listed as below:

Geno-type: *Xenopharynx solus*, Nicoll, 1913, in *Naja tripudians*, London Zoo.

Other species:

X. piscator Bhalerao, 1926, in *Tropidonotus piscator*; Kamayut Rangoon.

X. biliphaga Srivastava, 1954, in *T. piscator*; Lucknow.

X. indica Baugh, 1956, in a colubrid snake; Banaras Cantt.

X. pyriformis Simha, 1958, in *Ptyas mucosus*; Hyderabad.

X. heterovitellatus Simha, 1958, in *T. piscator*; Hyderabad.

X. Orientalis, n. sp. in *T. piscator*; Raipur.

X. nicolli, n. sp. in *T. piscator*; Raipur.

X. mehrai, n. sp. in *T. piscator*; Raipur.

X. raipurensis, n. sp. in *T. piscator*; Raipur.

Key to species of the genus *Xenopharynx* Nicoll, 1912.

	Oral sucker smaller than ventral sucker ...	1
	Oral sucker larger than ventral sucker ...	2
1.	Posterior extent of vitellaria upto level of testes, testes in third quarter of body ...	*X. pyriformis.*
	Posterior extent of vitellaria beyond posterior testis upto level of uterine coils, testes in posterior half of body ...	*X. piscator.*
2.	Testes symmetrically placed at same level ...	3
	Testes diagonal ...	5
3.	Testes unequal in size in posterior half of body, posterior extent of vitellaria in front of anterior border of testes ...	*X. nicolli*, n. sp.
	Testes equal in size ...	4
4.	Posterior extent of vitellaria uneven, testes in middle of body. ...	*X. mehrai*, n. sp.
	Posterior extent of vitellaria even beyond testes which are in anterior half of body ...	*X. Orientalis*, n. sp.
5.	Posterior region of cirrus sac overlapped by ventral sucker. ...	*X. indica.*
	Cirrus sac away from ventral sucker. ...	6
6.	Testes in anterior half of body ...	7
	Testes in posterior half of body, vitellaria not extending beyond testes ...	8
7.	Posterior extent of vitellaria even, Oesophagus small ...	*X. biliphaga.*
	Posterior extent of vitellaria uneven, Oesophagus large ...	*X. raipurensis*, n. sp.
8.	Vitellaria extending upto level of anterior testis, uterine coils not extending beyond testes ...	*X. heterovitellatus.*
	Vitellaria extending upto level of posterior testis, uterine coils extending beyond testes ...	*X. solus.*

ACKNOWLEDGEMENTS

The author is grateful to Dr. R. N. Singh, Reader in Zoology, College of Science, Raipur for his keen interest and guidance in this work. Thanks are also due to Principal Dr. K. Singh, College of Science, Raipur for providing necessary research facilities. His thanks are also due to Sri J. N. Saksena, Lecturer in Zoology, College of Science for help in [illegible] and to Sri N. B. Diwate, for collection of hosts.

REFERENCES

Baugh, S. G. 1956. Contributions [illegible] Trematodes, II. *Proc. Nat. Acad. Sci.* XXVI, (B) 297-313.

Bhalerao, G. D. 1926. On the [illegible] a Water snake, *Tropidonotus piscator*. *Parasit.* XVIII, 4-13.

Khalil, M. 1923. On a trematode from the gall bladder of *Natrix* [illegible] with an amendment of the genus *Xenopharynx* Nicoll, 1912. *Jour. Helminth.* I, 2-13.

Mehra, H. R. 1931. A new genus [illegible] Odhner (Trematoda) from a tortoise with a systematic [illegible] and classification of the family. *Parasit.* XXIII, 157-178.

——— 1937. Certain new and [illegible] Dicrocoeliidae Odhner, (Trematoda), with a discussion and [illegible] *Zeits. f. Parasitk.* IX, *Heft* 4, 454-467.

Nicoll, W. 1912. On two new [illegible] from [illegible] *Proc. Zool. Soc. Lond.* (4) 851-856.

Poche, F. 1925. Das System der Plathelmia [illegible], Vol. 1, *Heft* 2, 141-144.

Simha, S. S. 1958. Studies on the trematode parasites of [illegible] Hyderabad State. *Z. Parasit.* Vol. 18, 8. 161-218.

Srivastava, N. N. 1954. On a new trematode, *Xenopharynx fish hagia* sp. nov. from the gall bladder of fresh water snake, *Tropidonotus piscator*. *Ind. Jour. Helminth.* Vol. VI, No. 1, 13-18.

Strom, J. 1923. Beitrage zur Systematik der Trematoden der Gattung *Xenopharynx* Nicoll 1912 im Zusammenhang mit der Beschreibung einer neuen Art, [illegible] *Zool. Anz.* LXXIX, 167-172.

Yamaguti, S. 1958. 'Systema Helminthum' Vol. I The digenetic trematodes of Vertebrates Part I & II, Interscience Publishers, Inc., New York.

EFFECT OF CERTAIN CHEMICALS ON THE GROWTH OF SAL SEEDLINGS

By

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[Received on 6th March 1959]

INTRODUCTION

Sal (*Shorea robusta* Gaertn. f.) is an important timber tree of India. The problem of Sal regeneration has drawn the attention of most of the workers in the field. Several views have been expressed on the chemical requirement of Sal tree and its seedlings. Mooney (1947) has remarked that Sal primarily grows on acidic soils. Griffith and Gupta (1947) observed that 2% of organic matter is not detrimental to Sal seedlings. Puri and Sharma (1951) believe that Sal regeneration suffers on the soil rich in organic matter. Puri (1951) has suggested that poor regeneration of Sal in U. P. is probably due to decrease in soil acidity causd by the evaporation from surface soil in felled areas. Further, Puri (1952) noted that much of calcium and magnesium are returned to the soil by leaf litter but phosphorus, potassium and nitrogen do not return which adversely effect Sal regeneration. Hewetson (1953) remarked that Sal does not require high amount of mineral nutrient to survive. Puri (1951 a) and Khan (1953) have also reported the occurrence of Sal on different types of rock and soil which are acidic in nature and poor in calcium.

The present investigations were, therefore, designed to know the effect of certain chemicals on the growth of Sal seedlings as a step in its nutritional requiremens.

The experiments were conducted in the Department of Botany (inside the laboratory) at Mahakoshal Mahavidyalaya, Jabalpur, during the month of June, 1958. Jabalpur does not come under Sal climate.

CLIMATE

The climate of Jabalpur is salubrious. Rainy season commences from middle of June and extend up to early September when about 1250 m. m. of rains are received. August is the wettest month when mean temperature is 27° C. Winter season starts from November and continues upto February when the mean maximum and minimum temperatures are 26° C. and 10° C respectively. Winter rain seldom exceeds more than 60 m. m. The month of March has a transitional climate between winter and summer. Summer season extends from April to middle of June when the mean temperature goes to 38·5° C. However, somewhere in May an absolute maximum temperature of 47° C may sometimes be experienced.

Seedlings were grown under different treatments in specially prepared sandy alluvium.

Sandy alluvium brought from adjoining stream was ignited in an electric muffle furnace at 800° C. for 12 hours to remove its organic matter. It was allowed to cool and then dissolved in excess of 0·2 N glacial acetic acid and kept overnight to leach its bases. After filteration leachate was rejected. The residual sand was washed thrice with distilled water, dried and finally used for the experiments.

A normal culture solution was prepared by dissolving the following ingradients in a litre of distilled water :

Calcium chloride fused	...	2·84 gms.
Potassium hydrogen phosphate	...	0·71 gm.
Magnesium chloride	...	0·71 gm.
Ferrous ammonium sulphate	...	in traces.
Sodium nitrate	...	0·71 gm.

In addition to the usual ingradients of a culture solution sodium nitrate also was added in this normal solution to ascertain the effect of the element on the growth of Sal seedlings.

Sal seedings raised in petri-dish were transferred to culture pots. At the time of transplanting, the seedlings were about 2 weeks (since germination) old ; during this period roots and foliage shoots were adequately developed.

In all 7 replicates having one pot for each treatment were arranged.

The following solutions were added separately to each pot once every day, keeping in view the available moisture in the surface soil ; nearly 20 c. c. of the solution was added at a time :

1. Normal culture solution.
2. Normal culture solution plus 0·001% solution of indole acetic acid 1-3.
3. Calcium chloride deficient normal culture solution.
4. Potassium hydrogen phosphate deficient normal culture solution.
5. Magnesium chloride deficient normal culture solution.
6. Ferrous ammonium sulphate deficient normal culture solution.
7. Sodium nitrate deficient normal culture solution.

OBSERVATIONS

TABLE I

Effect of certain Chemicals on the Growth behaviour of Sal Seedlings.

No.	Type of treatment	INITIAL OBSERVATIONS					FINAL OBSERVATIONS				REMARKS
		Date of transplanting.	Age of sapling in days.	Height of the plant in cm.	Total no. of leaves	l/b. of maximum sized leaf.	Date of last observation.	Height of the plant in cm.	Total no. of leaves.	l/b. of maximum sized leaf.	
1.	Normal culture solution.	27-6-58	14	5·0	2	4·6 / 2·4	25-8-58	...	...	...	died
2.	Normal culture solution plus indole acetic acid.	3-7-58	16	5·5	2	5·3 / 2·9	8-9-58	9·3	2	2·5 / 1·5	Experiment was closed.
3.	Calcium chloride deficient normal culture solution	29-6-58	13	5·4	2	4·9 / 2·5	4-8-58	...	...	...	died.
4.	Potassium hydrogen phosphate deficient normal culture solution.	27-6-58	14	5·5	3	5·2 / 2·2	2-7-58	...	...	...	died.
5.	Magnesium chloride deficient normal culture solution.	27-6-58	9	4·8	2	4·5 / 2·5	2-7-58	...	...	...	died
6.	Ferrous ammonium sulphate deficient normal culture solution.	29-6-58	13	6·2	3	5·5 / 3·8	18-8-58	...	...	...	died.
7.	Sodium nitrate deficient normal culture solution	29-6-58	13	6·8	2	5·2 / 2·9	8-9-58	14·1	3	7·7 / 4·9	Experiment was closed.

N. B. l/b.—length/breadth in cm.

From table 1 it is noted that in pot numbers 4 and 5, which were deficient of magnesium, potassium and phosphorus, the seedlings died within a week, thereby, showing the essentiality of these elements.

With calcium deficiency the seedling turned pale and gradually bent down; the plant ultimately died in about 5 weeks.

The young plants treated with normal culture solution and ferrous ammonium sulphate deficient normal culture solution have shown poor growth and the plants died within 2 months of the treatments.

In pot no. 2 having indole acetic acid the seedling grew moderately till the time of closing the experiment.

Sodium nitrate deficient normal culture solution was supplied to pot no. 7 where the seedling showed the best growth. The young plant here attained the height of 14·1 cm. and had 3 leaves at the end of the experiments (in the period of 3 months). The root system was not well developed (see plate 1).

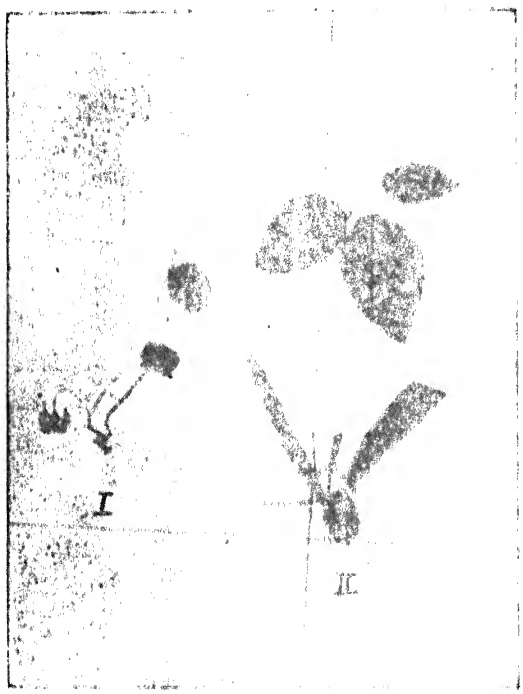

PLATE 1.

SAL SEEDLING AFTER 3 MONTHS OF GROWTH IN SAND CULTURE POTS

I—The seedling supplied with normal culture solution plus indole acetic acid.

II—The seedling supplied with sodium nitrate deficient normal culture solution.

CONCLUSION

The above experiments reveal the probability that for the growth of Sal (*Shorea robusta* Gaertn. f.) seedling calcium, potassium, phosphorus, magnesium, iron, sulphur, nitrogen and chlorine are necessary whereas sodium appears to be harmful.

DISCUSSION

The present observations are in confirmation with those of Weaver and Clements (1938) who have noted that for normal growth, plants need only the soluble salts of nitrogen, sulphur, phosphorus, potassium, calcium, magnesium, iron and sometimes chlorine.

While sodium has not been generally considered as essential to growth and development of plants by many workers at the same time it has been reported to be extremely toxic to certain plants, as investigated by Beaument (1932). Much work has been done on the inhibitory effect of sodium on plants. Mukherjee, Satyanarayana and Rao (1959), Mukherjee and Venkataraman (1959) and Sarin and Rao (1959) have very recently reported about the harmful effects of this element on plants.

SUMMARY

Sand culture experiments were undertaken to evaluate the nutritional requirements of Sal (*Shorea robusta* Gaertn. f.) seedlings.

In addition to normal culture ingradients sodium nitrate was also added to know its effect on the plant growth. 7 replicates having one pot for each treatment were arranged. One of the pot was supplied with normal culture solution; another by normal culture solution plus 0.001 % solution of indole acetic acid and rest of the pots were separately treated every day with normal culture solution deficient in one of its constitutents. The experiments have shown that for the growth of Sal seedling potassium, magnesium, phosphate, calcium, iron, sulphur, nitrogen and chlorine are probably necessary. The presence of sodium has proved inhibitory for the growth of the plant.

ACKNOWLEDGEMENT

I am very much grateful to Dr. S. C. Pandeya, Department of Botany, Science College, Raipur, for the kind guidance, everlasting interest and constant encouragement during the entire period of this investigation.

LITERATURE CITED

Beaument, A. B. 1932. Toxicity of sodium nitrate for a species of moss, *Sci.*, 75: 312-313.

Gullih, A. L. & Gupta, R. S. 1947. The determination of the characteristics of soil suitable for Sal. *Indian For. Bull.* no. 138.

Hewetson, C. F. 1954. A discussion on the ecological position of Sal in Central India. *Indian For.* 79, (6):

Khan, M. A. W. 1953. Effects of geological formations on the distribution of Sal. *Indian For.* 79, (9)

Mooney, H. F. 1937. A note on the southern limit of Sal (*Shorea robusta*) in Orissa and Bastar state. *Indian For.* 20 (27-31).

Mukherjee, K. L., Satyanarayan, K. & Rao, C. C. 1959. Physiological basis of Usar (Alkali) tolerance-I. Absorption of Na, K, and Ca. *Proc Indian Sci. Cong. abstract*, pt. III. 314.

Mukherjee, K. L. & Venkataraman, L. V. 1959. Physiological basis of usar (Alkali) tolerance-II. Relative absorption of water and sodium carbonate. *Proc. Indian. Sci. Cong. abstract.* Pt. III, 315.

Puri G. S. 1951. Ecological approach to the problem of Sal (*Shorea robusta*) regeneration in U. P. *Proc. 8th Silvi. Conf., Dehra Dun.*

—— 1951 a. Advances in the ecology of teak (*Tectona grandis*) in India. *Proc. 8th Silvi. Conf. Dehra Dun.*

—— 1952. The amount of foliar ash in Sal (*Shorea robusta*) trees of different classes in india. *J. Indian bot. Soc.* 31 (1 & 2): 82.

—— and Sharma, B. K. 1951. The ecology of some Sal (*Shorea robusta* Gaertn. f.) forests of Madhya Pradesh. *Proc. 8th Silvi. Conf., Dehra Dun.*

Sarin, M. N. & Rao, I. M. 1959. Physiological studies on salt-tolerance of crop plants—V. Use of IAA to overcome depressing effect of sodium sulphate on growth and maturity of wheat. *Proc Indian Sci. Cong. abstract*, Pt. III, 315.

Weaver, J. E. & Clements, F. E. 1938. Ecology. McGraw-Hill Book Co., Inc. New York.

STUDIES ON GALL MIDGES (ITONIDIDAE:CECIDOMYIIDAE-DIPTERA-NAMATOCERA) FROM INDIA

By

Dr. S. N. RAO *and* Miss P. GROVER

Department of Zoology, College of Science, Nagpur

[Received on 10th August, 1959]

Of the innumerable number of midges received for identification from various sources, only a part of the material has been attended to for the present paper. We include in this paper some midges mentioned for the first time from some of the States in India and record here informations regarding their parasites. In this paper has also been included the detailed description of a new species of the genus *Kamptodiplosis* Felt which is reported to be predaceous on mealy bugs on citrus plants at Bangalore. Incidently, this is the first record of this genus from our country. In addition, important informations regarding second or alternate host plant for *Asphondylia tephrosiae* Mani, which is also recorded for the first time, is included in the present paper.

The type slides are for the time being retained in the collection of the senior author.

Subfamily *Itonididinae*

Tribe *Lasiopterini*

Neolasioptera cephalandrae Mani

1943. *Neolasioptera cephalandrae*, Mani, *Rec. Indian. Mus.*, 36 (4) : 397 ♀.
1952. *Neolasioptera cephalandrae*, Rao, *Proc. R. Ent. Soc. London*, 21 : 51.
1956. *Neolasioptera cephalandrae*, Rao, *Ann. Mag. Nat. Hist., London*, (12) 9 : 69 (♂ ♀).

From among the specimens received for identification from the Goverenment Entomologist, Andhra Pradesh, Rajendranagar, (P. O.) Hyderabad-Dn. is a tube containing specimens in spirit labelled "gall flies, Loc. Andhra, Host : *Coccinia indica*, dated 12-11-58, Coll. St. Edwin. (A)". These were sent by Mr. C. Krishna Murty, M. Sc. (Ag.), F. R. E. S., Assistant Entomologist, R. S. B. Scheme, Bapatla, under his D. O. No. 108/58 dated the 14th Nov. 1958.

This midge which is previously reported from a large number of places in India (Rao-1955) is for the first time being reported from Bapatla in Andhra Pradesh.

This midge is parasatized by *Inostemma indica* Mani (1941)

Tribe *Dasyneurini*

Dasyneura lini Barnes

1936. *Dasyneura lini*, Barnes, *Ann. Mag. Nat. Hist.*, 17 (10) : 273-74.
1955. *Dasyneura lini*, Rao, *Agra Univ. J. Res.*, 4 (1) : 234.

We have before us few males and females reared by Miss P. Grover from the infected buds of linseed and labelled "Reared in the laboratory from infected buds of *Linum usitissimum* Le., Feb. 1959, Nagpur, Coll. P. G." and a very large number of the same midges reared by Dr. S. N. Rao on various occasions from 1953, in addition to one ♂ labelled "at light, Ramdaspeth, Nagpur, Coll. SNR, 16-2-1959."

This midge was previously recorded from Pusa (Bihar) and Delhi (U. P). This is reported to be a minor pest in these parts of the country and also attacks the tender buds of "*til* plant," (*Sesamum indicum* Linn.) in the rainy months.

This is parasatized by an unidentified *chalcid*.

Tribe *Asphondylini*

Asphondylia sesami Felt

1916. *Asphondylia sesami*, Felt, *Can. Ent.*, 48 : 31.
1956. *Asphondylia sesami*, Rao, *Ann. Mag. Nat. Hist.*, (12) 9 : 70.
1957. *Asphondylia sesami*, Rao, *Indian J. Ent.* 19 (1) : 3.

We refer to this species few females and one male "dissected and mounted on slides labelled S. N. R. Coll. Aug./Sept. 1958, Nagpur." and a large number of males and females reared by Dr. S. N. Rao, from the flower bud galls of *Sesamum indicum* Linn. here at Nagpur.

This midge, reported to be a minor pest at Hyderabad–Dn., is becoming more economically important at Nagpur. It is previously recorded from a variety of places from all over the country.

This midge is parasatized by *Eurytoma nesiotes* Crawford (1910) and *Inostemma* sp. (Pruthi and Mani 1940).

Asphondylia tephrosiae Mani

1943. *Asphondylia tephrosiae*, Mani, *Indian J. Ent.*, 5 : 152.
1955. *Asphondylia tephrosiae*, Rao, *Agra Univ. J. Res.*, 4 (1) : 245.
1957. *Asphondylia tephrosiae*, Rao, *Indian J. Ent.*, 19 (1) : 4.

We refer to this species several males and females received from Mr. N. P. Kalyanam, Lecturer in Zoology, Annamalai University, Annamalainagar in two lots under his letter Nos. nil dated the 2nd Sept. 1958 and 27th Dec. 1958. This is undoubtedly the same species as described before by Mani (1934) but is slightly different in its proportions of the antennal and the palpal segments.

Mani (1934) recorded this species at Delhi to be forming a gall on the ovary of *Tephrosia candida* De. The midges on hand were, however, reared by Mr. Kalyanam from *T. purpurea* Pers. Thus, this midge is now shown here to be causing galls on two different host plants.

This is for the first time that this midge is reported from Annamalainagar, Madras State.

Mr. Kalyanam (1957) reported that this midge is parasatized by *Neanastalus proximus* Kerr. (Eupelmidae : Hymenoptera).

Tribe *Trifilini*

Dyodiplosis fici Rao

1951. *Dyodiplosis fici*, Rao, *Indian J. Ent.*, 11 (2) : 123.
1955. *Dyodiplosis fici*, Rao, *Agra Univ. J. Res.*, 4 (1) : 257.
1957. *Dyodiplosis fici*, Rao, *Indian J. Ent.*, 19 (1) : 11.

From among the material under identification are found two males and one female which belong to this species. The material is dissected on slides and labelled "Aurangabad, Coll. PRD. 14-7-1959".

This species, producing disc-shaped galls on the leaves of *Ficus glomerata* Roxb., were first reported from Agra (Rao 1951). Subsequently Rao collected the same insect from Andhra and the central jail premises, Nagpur. This is the first time this midge is recorded from Aurangabad, Bombay State.

This is parasatized by an unidentified *Chalcid*.

Pachydiplosis oryzae (W. M.) Mani

1881. *Cecidomyia oryzae*, Wood-Masan in Riely, *Amer. Naturalist*. p. 149.
1913. *Cecidomyia oryzae*, Kieffer, *Gen. Ins.*, 152 : 217.
1921. *Pachydiplosis oryzae*, Felt, *Mem. Dept. Agri. India. Ent. Ser.*, 7 : 16.
1934. *Pachydiplosis oryzae*, Mani, *Rec. Indian. Mus.*, 36 (4) : 433 (Sp. first described).
1955. *Pachydiplosis oryzae*, Rao, *Agra Univ. J. Res.*, 4 (1) : 270.

We refer to one ♂ and two ♀♀ labelled "at light, Sept. Oct. 1957, Ravinagar, Nagpur, S. N. R. Coll". This is one of the injurious midges to the Rice crop. It is reported from various rice growing regions of our country in addition to Java and Formosa.

This notorious midge is parasatized by *Proleptocis oryzae* Rao (1950).

Kamptodiplosis indica, sp. nov.

♂ Length 1·00 mm. Body light brown to dark brown. Eyes confluent above. Antenna light brown, incomplete with thirteen segments, flagallate segments binodose with short stems gradually becoming narrower towards apex, with two whorls of long setae, one on basal and second on apical enlargements, circumfila in three whorls, regular, one whorl on basal and two on apical enlargements, middle whorl slightly shorter than the other two ; first segment (fig 18) pale yellow, widest at apex, maximum width nearly one and one-third its length, with long setae ; second segment (fig. 18) subglobose, smaller than first segment, width one and a half times its length ; third segment (fig. 3) fused with fourth segment, three times the length of first segment and greater than first and second segments combined, basal enlargements as long as thick, globose, basal stem short, broader than long, length three-fifths the breadth and nearly one-fourth that of basal enlargement, apical enlargement as thick as basal enlargment and a little longer than its width, wider apically than at base, apical stem nearly as long as thick and one and one-third times longer than basal stem and three times greater than apical enlargement ; fourth segment (fig. 3) longer than third segment, basal enlargement nearly as long as thick, basal stem as long as thick and half the length of basal enlargement, length of apical enlargement one and one-fifth times its diameter and one and one-third that of basal enlargement, apical stem a little longer than its width but equal to basal stem ; fifth segment (fig. 4) a little longer than fourth segment, basal enlargement a little less than one-fourth the length of segment, length of basal enlargement a little less than its width, basal stem as long as thick and nearly half the length of basal enlargement, apical enlargement longer than basal enlargement, length a little more than its width, apical stem longer than basal stem and half the length of apical enlargement and also one and half times its own diameter, sixth segment (fig. 4) longer than fifth segment, basal enlargement a little less than one-fourth the length of the segment, nearly as long as thick, length

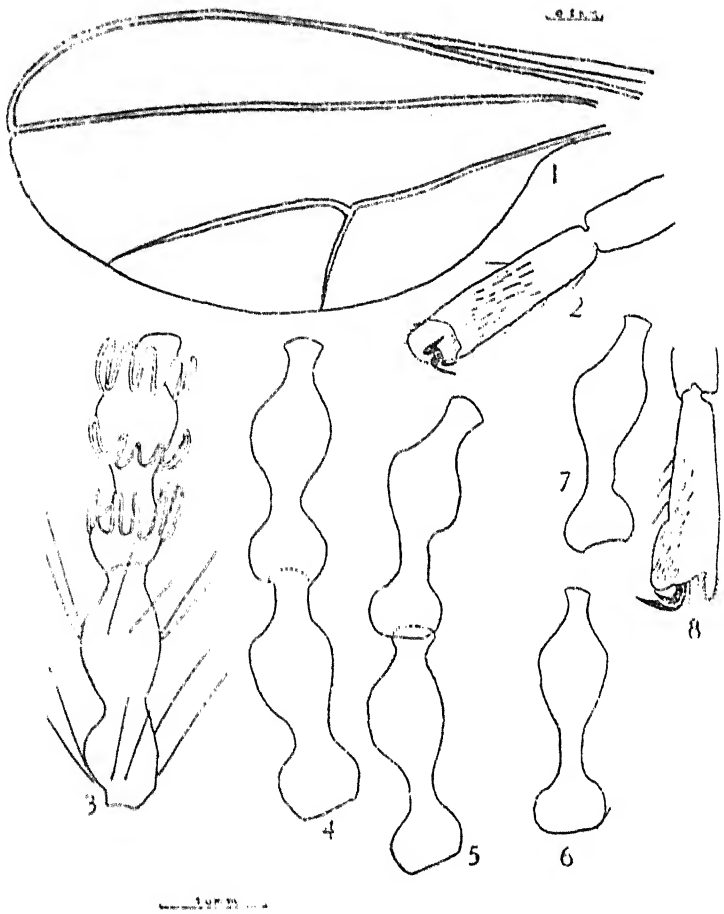

Fig. 1. Wing of male.

„ 2. Claw of male.

„ 3. Third and fourth antennal segments of male.

„ 4. Fifth and sixth antennal segments of male.

„ 5. Ninth and tenth antennal segments of male.

„ 6. 13th antennal segments of male.

„ 7. 12th antennal segment of male.

„ 8. Hind claw of male.

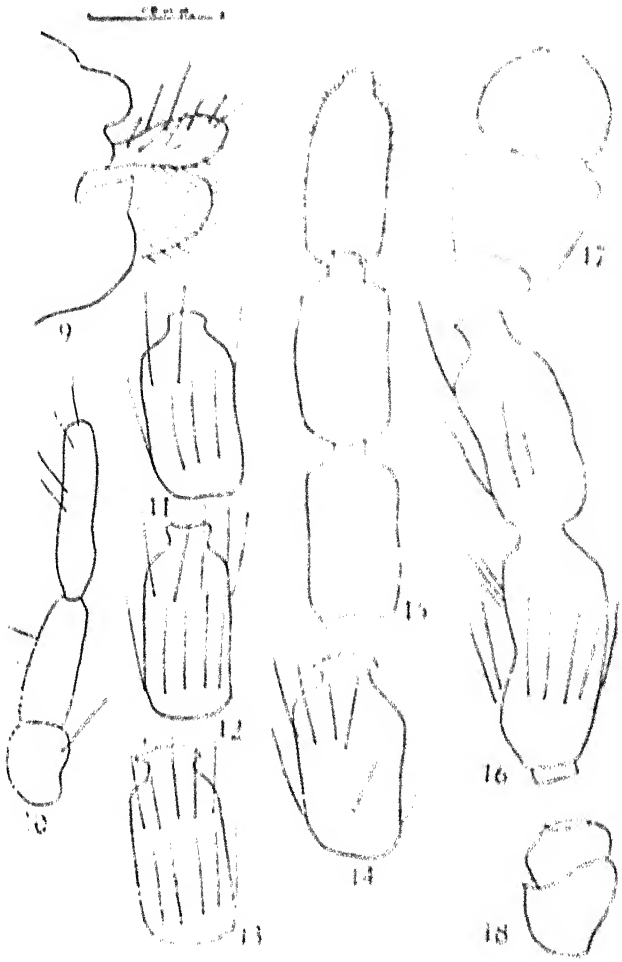

Fig. 9. Ovipositor.
" 10. Papli of male.
" 11. Tenth antennal segment of female.
" 12. Ninth antennal segment of female.
" 13. Seventh antennal segment of female.
" 14. Fifth antennal segment of female.
" 15. Terminal three antennal segments of female.
" 16. Third and fourth antennal segments of female.
" 17. First two antennal segments of female.
" 18. First two antennal segments of male.

of basal stem one and one-fourth times its own diameter and a little less than half the length of basal enlargement, apical enlargement similar to the preceeding segment, apical stem longer than basal stem and a little longer than half the length of apical enlargement, nearly twice its own width ; ninth segment (fig. 5) nearly similar to sixth segment ; tenth segment (fig. 5) as long as ninth segment, width of basal enlargement one and one-fourth times its diameter and nearly one-fourth the length of segment, basal stem nearly twice as long as thick and a little less than basal enlargement, apical enlargement as long as thick and a little less than one-third the length of segment, longer than basal enlargement, basal stem twice as long as thick ; twelfth segment (fig. 7) shorter than tenth segment, nearly similar in other details except for the narrower apical stem ; thirteenth segment (fig. 6) longer than twelfth but equal to fifth segment, basal enlargement narrower than rest of segments, length a little less than one-fifth the length of segment, basal stem longer than apical stem and thrice as long as thick, apical enlargement longer than its own diameter, apical stem nearly half the length of basal stem and two-third times as long as broad. Palpi, (fig. 10) pale yellow, triarticulate, sparsely setose, first segment longer than broad, length one and two-fifth its maximum diameter, second segment longer than first segment, cylindrical, slightly broader at base, as long as thick, third segment cylindrical, longest of all, longer than first and second segments combined, length four and a half times its diameter. Mesonotum dark brown, scutellum and post scutellum light brown, scutellum paler than post scutellum. Abdomen light brown. Wing (fig. 1) hyline, oblong, a little over twice as long as broad, *Rs* absent, *Sc* joining the costa at about the basal one-third, R_5 straight and reaching the wing margin beyond the apex, M_{1+2} absent, M_4 and $m-cu$ forked. Halteres pale yellow. Legs pale yellow, long, densely hairy, claw bifid, bent at right angle, empodium shorter than claw (figs. 2, 8).

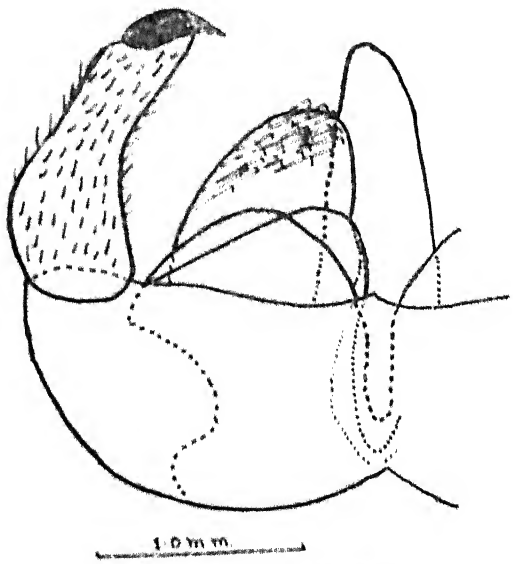

Fig. 19. Genitalia.

Genitalia (fig. 19) brown, sparsely setose, basal clasp segment without a basal lobe, longer than broad, length nearly one and three-fourths the maximum breadth, terminal clasp segment short, slender, shorter than basal clasp segment, gradually tapering at the apex and ending in a thick blunt tooth,

length three and half times the maximum breadth, more closely setose than basal clasp segment, dorsal plate short, broad, deeply and broadly cleft in middle, lobes divergent, broad, rounded, fairly setose, emarginate, ventral plate narrower than dorsal plate, as long as dorsal plate, deeply and broadly cleft in middle, lobes narrowerly rounded at apex, divergent, moderately hairy and fairly setose; style long, slender, longer than dorsal and ventral plates, broad at base and narrowed at apex, harps beset with recurved thick hairs.

♀ length 1·12 mm. Body redish brown to light brown. Eyes confluent above. Antenna shorter than body, light brown with fourteen segments, with short stems and two whorls of long setae; first segment (fig. 17) pale yellow, longer than second segment, broader apically than at base, length nearly equal to maximum width; second segment (fig. 17) subglobose, length nearly equal to its diameter, darker and smaller than first segment; third segment (fig. 16) cylindrical with a short stem and fused with fourth segment, with very little constriction in middle, length little more than twice its width; fourth segment shorter than third, cylindrical, constriction less prominant at the basal two-fifths, length, little less than twice its breadth; fifth segment (fig. 14) shorter than fourth segment, constriction less pronounced, length less than twice its width, stem short; seventh segment (fig. 13) nearly equal to fifth segment, length twice its width; ninth segment (fig. 12) cylindrical, with very slight constriction, shorter than seventh segment, length a little longer than twice its diameter; tenth segment (fig. 11) shorter than ninth segment, length, twice its own width; twelfth segment equal to tenth segment in length but little slender; thirteenth segment similar to tenth sagment but slightly shorter; terminal segment (fig. 15) similar to twelfth segment, slender than penultimate segment, with a slight constriction in the basal half and much conspicuous constriction in apical one-fourth producing a knob like structure, knob one-fifth the length of segment and a little less than twice its diameter. Palpi pale yellow, triarticulate, long, sparsely setose; first segment globose, length nearly equal to its breadth; second segment oblong, length two and two-fifth of its diameter; third segment longer than second segment, length twice its own breadth, slender and oval. Mesonotum dark brown, scutellum light brown and post scutellum pale yellow. Abdomen light brown. Wing as in male. Claw bifid, bent at right angle, dark brown, longer than empodium. Ovipositor exserted (fig. 9) with one long and two basal small elongated lobes.

Holotype 1 ♂ dissected and mounted on slide and labelled "reared from mealy bug on citrus, C. S. 35-A, VPR Coll. Bangalore" from the material received for identification from Dr. V. P. Rao, Asstt. Director, (Biological control) Bangalore, under his D. O. No. 9/39/56 dated the 17th April 1956.

Allotype one ♀ dissected and mounted on slide and leballed as the holotype.

Felt (1918) was doubtful about the number of antennal segments of the species described. In the case of *K. indica* sp. nov. it is definite that the antenna consists of 14 segments. This species undoubtedly belonging to *Kamptodiplosis* Felt differs from the only known oriental species of the genus *K. reducta* Felt (1918) in the third and fourth antennal segments being confluent, in the hind claw being bifid and proportions of the antennal and palpal segments as well as in the structure of the genitalia.

ACKNOWLEDGMENTS

We are grateful to the various authorities, acknowledged elsewhere in this paper, for the supply of material. We are also grateful to the authorities of the College of Science, Nagpur, for all the facilities provided in completing this work.

Our thanks are also due to Dr. M. D. L. Srivastava, Professor and Head of the Zoology Department, Allahabad University, in whose laboratory a part of this work was carried out by the junior author in the summer months of 1959.

LIST OF REFERENCES

Barnes, L. F. 1936. *Ann. Mag. Nat. Hist.*, 17 : 273.

Crawford, D. L. 1913. *Proc. U. S. Nat. Mus.*, 38 : 129.

Felt, E. P. 1916. *Gen. Ent.*, 48 : 31.

——— " 1918 *Phil. J. Sci.*, 13 : 209.

——— " 1921. *Mem. Dept. Agric. India, Ent. Ser.*, 7 : 16.

Kalyanam, N. P. 1957. *Madras Agri. J.*, 44(7) : 303.

Kieffer, J. J. 1913. *Gen. Ins., Fas.*, 152 : 217.

Mani, M. S. 1931. *Rec. Indian, Mus.*, 36(4) : 433.

——— " 1941. *Cat. Indian Ins.*, 26 : 32.

——— " 1943. *Indian J. Ent.*, 5 : 152.

Puttbi, H. S. & Mani, M. S. 1941. *Misc. Bull. Imp. Council Agric. Res. India*, 30 : 149.

Rao, S. N. 1950. *Rec. Indian Mus.*, 48 : 57.

——— " 1951 *Indian J. Ent.*, 11(2) : 123.

——— " 1952. *Proc. R. ent. Soc. London*, 21 : 51

——— " 1955. *Agra Univ. J. Res.*, 4, 1) : 234.

——— " 1957. *Ann. Mag. Nat. Hist.*, (2)9 : 70.

——— " 1957. *Indian J. Ent.*, 19(1) : 4.

A NEW AND PECULIAR TYPE OF GERMINATION OBSERVED IN SAL (*Shorea robusta* Gaertn f.) SEEDS

By

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[Received on 6th March, 1959]

While dealing with the study of *Sal* (*Shorea robusta* Gaertn f.) seeds an interesting and peculiar mode of germination has been observed. Morphology and structure of the seed is also interesting which support the phenomenon of germination.

MORPHOLOGY AND STRUCTURE OF SEED

Sal bears tricarpellary single seeded windged fruit. Upon removing the thin indehiscent and fused fruit wall the seed is exposed. It is oval in shape with accuminate apex (fig. 1, II). The seed consists of the testa and the embryo. Testa is a thin, wide membranous sheath covering the cotyledons ; tegmen is not seen. On removing the seed coat embryo is exposed. The embryo consists of following parts :—

(*i*) *The two fleshy cotyledons* :—The cotyledons are unequal in size and are obliquely placed in the seed (fig. 1). The bigger cotyledon is placed on the obtuse side of the seed (towards the joint of fruit stalk). This bigger cotyledon is completely grooved throughout on its outer periphery so that it is liable to split in two equal parts, which generally happens during germination. It may be mentioned here that in the above noted groove runs a dry white sheath, the morphology of which can not be said with certainty. The smaller cotyledon is towards the upper side of the seed. Being obliquely placed the upper portion of it makes the accuminate apex. It is actually a grooved apex.

(*ii*) *A short axis* :—The axis is inverted 'V' in shape attached with its one arm to the upper cotyledon near its groove and with the other arm attached to the lower cotyledon at its centre (fig. 1, V). Thus, the joint of the axis with the bigger cotyledon is inside the seed, being situated between the two cotyledons. The joint with the upper and smaller cotyledon can easily be seen outside the seed. Since the axis is joined to the cotyledons at two different positions ; the 'joints' connecting the axis with the cotyledons are longer than found in normal dicot seeds. The base of the 'V' shaped axis is directed towards the apex of the seed. Another remarkable feature is the fact that plumule is not visible in the axis prior to germination.

MODE OF GERMINATION

Upon germination the axis which is not distinguishable into radicle or plumule is pushed out by the cracking of the fruit wall and the testa near the apex. This pushing is brought out by the elongation of the two 'joints' of the axis (fig. 2). Since the two 'joints' are placed at different positions, they grow distinctly and may become even as long as 1 to 1½" long. The axis which is carried at the fused

tip of these joints is still not distinguishable into radicle and plumule. With the elongation of the 'joints' the axis also elongates and soon becomes 1½ to 2" long bearing minute secondary roots on it, thereby, showing that it has given rise to the primary root (fig. 2, 4). From the point at which thus formed primary root is connected to the 'joints' a small slit is formed through which gradually the plumule emerges out. The root establishes itself in the soil and plumule grows further giving out foliage leaf. This peculiar mode of germination gives an idea of the germination seen in date palm seed in which also a portion of the cotyledons breaks up through the seed coat and elongates in the form of a sheath enclosing the axis of the embryo inside it and later this axis gives rise to coleorhiza and coleoptile.

So for as the author is aware such a peculiar mode of germination has not been observed in any of the dicot seeds. This is, therefore, the first record of the type and, hence, this mode of germination may be called the "Sal type of hypogeal germination".

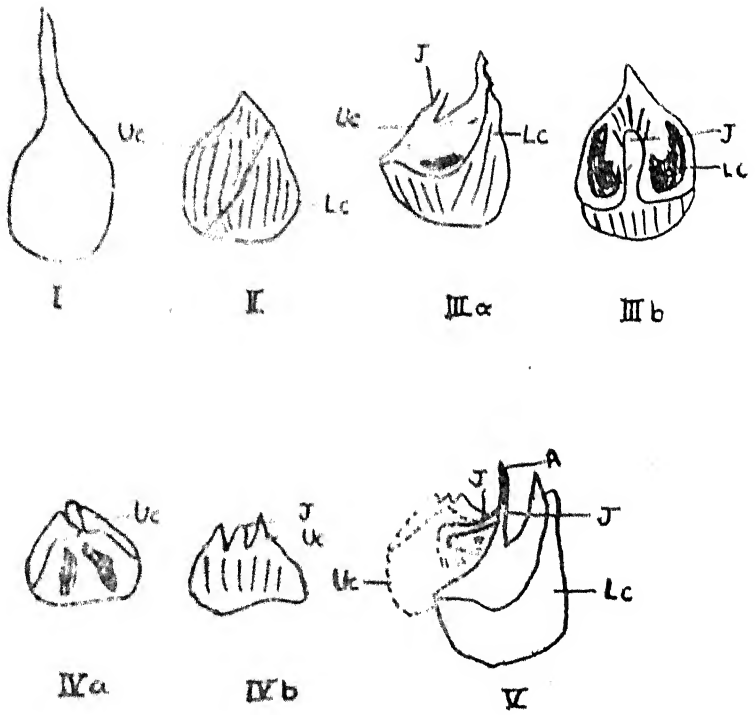

Fig. 1

STRUCTURE OF SAL SEED

Uc — Upper cotyledon ; Lc — Lower cotyledon ; J — joint ; A — Axis.

I — Intact seed ; II — Seed after removing pericarp; IIIa and IIIb — Lateral views showing lower cotyledon; IVa and IVb — Lateral view showing upper cotyledon; V — Lateral view showing the attachment of the joints with the cotyledons. Note the axis.

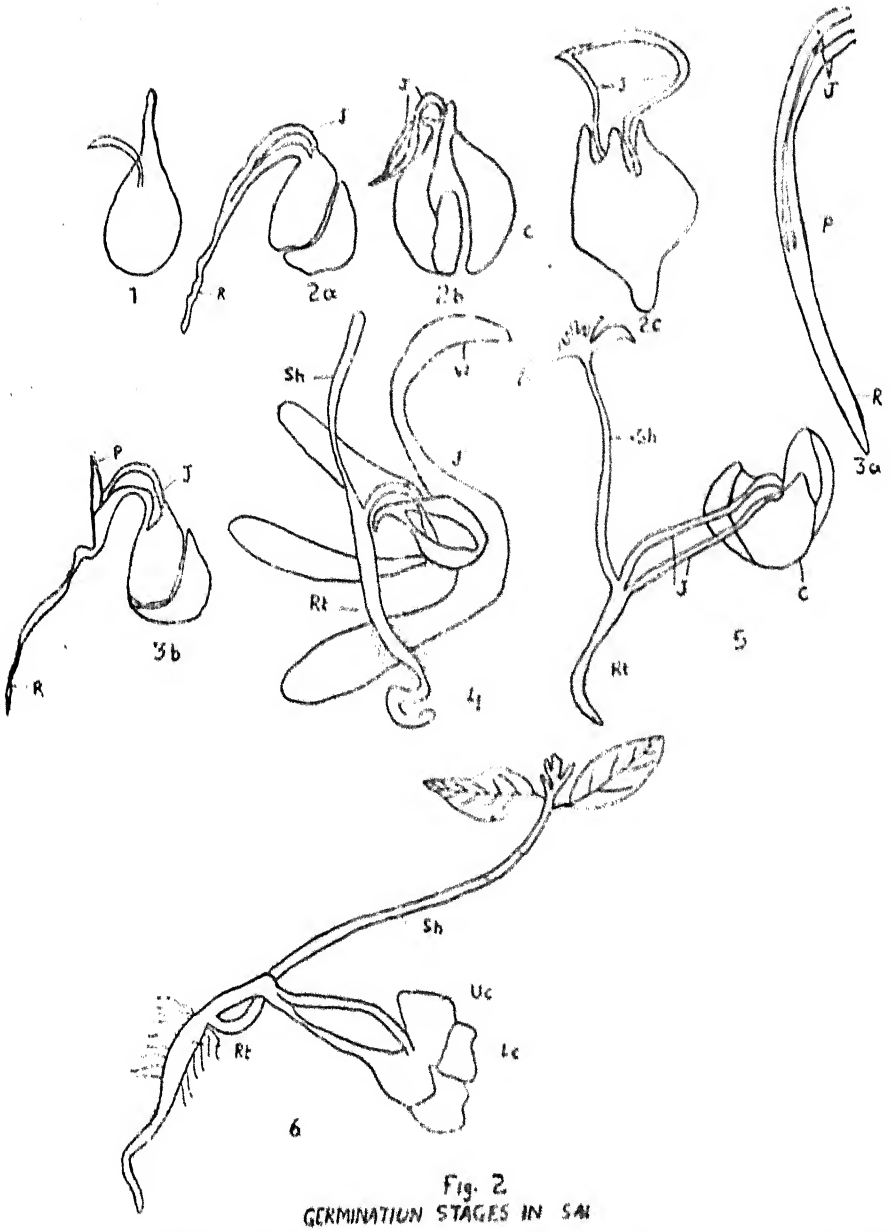

Fig. 2
GERMINATION STAGES IN SAL

J— joint; R— Radicle; C— Cotyledon; P — plumule; Sh — Shoot; Rt — Root; W — Wing; Uc— Upper cotyledon; Lc—Lower cotyledon.

1. Seed with short axis; 2a, 2b and 2c — Elongation of the two joints bearing axis from different views; 3a— Dissected axis showing plumule in the initial stage; 3b — Plumule emarges from the axis and the radicle elongates; 4 — Appearance of root and shoot; 5 and 6— Advanced stages in the leafy shoot.

SUMMARY

Sal (*Shorea robusta* Gaertn f.) shows a new and peculiar mode of germination. The structure of the seed which is inside the single seeded winged fruit is peculiar in itself and closely reflects the mode of germination.

The embryo consists of two unequal and fleshy cotyledons which are obliquely placed. The bigger cotyledon is on the obtuse side of the seed. The short axis which is inverted 'V' in shape is attached with one arm to the upper cotyledon near its groove and with other to the lower cotyledon at its centre.

Upon germination the short axis which is not distinguishable into radicle or plumule is pushed out by the elongation of the two 'joints' through the cracking of the fruit wall and testa near the apex. The 'joints' and the axis further elongate and the axis gives rise to primary root bearing minute secondary roots on it. At the junction of the primary root with the 'joints' a small slit is formed through which plumule emerges out and gradually gives rise to shoot bearing foliage leaf.

This mode of germination may be called the "*Sal* type of hypogeal germination".

ACKNOWLEDGEMENT

The author is greatly indebted to Dr. S. C. Pandeya, Botany Department, now of Science College, Raipur and formerly of Mahakoshal Mahavidyalaya, Jabalpur, for valuable guidance and encouragement during the course of study.

FUNGI CAUSING PLANT DISEASES AT JABALPUR (MADHYA PRADESH)—I

By

G. P. AGARWAL, K. G. NEMA* *and* R. BELIRAM

Botany Department, Mahakoshal Mahavidyalaya, Jabalpur

Read at the 28th Annual Session of the Academy held at University of Agra.

Knowledge about the parasitic fungal flora of Madhya Pradesh, comprising an area of 170351 sq. miles, one of the biggest States of India, is scanty and a systematic collection of fungi has yet to be made. However, presently it is intended to publish, in a series of papers, the parasitic fungi occurring both on the cultivated and wild plants at Jabalpur and its suburbs. Jabalpur is situated in 23°3′ N. Latitude and 79°57′ E. Longitude in a rocky basin about 1280 feet above sea level surrounded by granittic hills which are not more than 1600 feet above the sea level. The city, lying near the geographical centre of India, experiences a typical monsoon climate. The summers are hot, winters cool and most of the rains i. e. 56·3 inches fall between June and October. The present paper is the first in the series.

The specimens have been deposited in the Herbarium of the Botany Department, Mahakoshal Mahavidyalaya, Jabalpur and most of the specimens are also kept in the Herbarium of Plant Pathology Section, College of Agriculture, Jabalpur.

PHYCOMYCETES

1. *Cystopus candidus* (Pers.) Lev. on leaves of *Raphanus sativus* L., Sunday Vegetable Market, December, 1957, Leg. G. P. Agarwal.

2. *C. bliti* (Biv.) de Bary on leaves of *Amarantus spinosus* L., Govt. Farm, Adhartal, 8.8.57, Leg. K. G. Nema, on leaves of *Amaranthus blitum* L. Pachpedhi, 12.12.57, Leg. G. P. Agarwal.

3. *C. ipomoeae-panduratae* (Schw.) Stev. & Swingle on leaves of *Ipomea* sp., Miloniganj, 9.8.57, Leg. K. G. Nema.

4. *Peronospora parasitica* (Pers.) de Bary on leaves of *Raphanus sativus* L., Newarganj, 19.10.57, Leg. G. P. Agarwal & K. G. Nema.

5. *P. arborescens* (Berk.) de Bary on leaves of *Argemone mexicana* L., Adhartal, 19.12.56, Leg. K. G. Nema.

6. *P. effusa* (Grev.) Rabenh. on leaves of *Chenopodium album* L., Adhartal, 19.12.56, Leg. K. G. Nema.

7. *P. viciae* (Berk.) de Bary on leaves of *Pisum sativum* L., Govt. Farm, Adhartal 1.2.57, Leg. G. P. Agarwal & K. G. Nema; on leaves of *Lathyrus sativus* L. and *Trigonella* sp., Adhartal, Feb., 1957, Leg. K. G. Nema & C. G. Shinkhede.

*Lecturer in Mycology, College of Agriculture, Jabalpur.

8. *Phytophthora parasitica* Dastur on leaves of *Piper betle* L., Gupteshwar, 13.11.58, Leg. K. G. Nema.

9. *P. colocasiae* Rac. on leaves of *Colocasia antiquorum* Schott., Sunday Vegetable Market, November, 1957, Leg. G. P. Agarwal.

10. *Pythium aphanidermatum* (Eds.) Fitz. on fruits of *Lagenaria vulgaris* Ser., Miloniganj, Novembar, 1956, Leg. K. G. Nema.

ASCOMYCETES

11. *Erysiphe cichoracearum* DC. on leaves of *Lagenaria vulgaris* Ser., *Cucurbita pepo* L., and *Hibiscus esculentus* L., Govt. Farm Adhartal, October, 1956, Leg. K. G. Nema.

12. *E. polygoni* DC. on leaves of *Pisum sativum* L., Govt. Farm, Adhartal, 1.2.57, Leg. G. P. Agarwal & K. G. Nema.

13. *Sphaerotheca euphorbiae* (Cast.) Salmon on leaves of *Euphorbia hirta* L., College area, Dec. 1958 and Jan., 1959, Leg. R. C. Agnihotri.

S. euphorbiae has been reported on other species of *Euphorbia* but *E. hirta* is a new host record.

14. *Uncinula tectonae* Salmon on leaves of *Tectona grandis* Lim. f., Sadar, January, 1957, Leg. G. P. Agarwal.

15. *Phyllactinia corylea* var. *subspiralis* Salmon on leaves of *Dalbergia sissoo* Roxb., Sadar, 27.12.57, Leg. G. P. Agarwal.

16. *Phyllachora cynodontis* (Sacc.) Niessl. on leaves of *Cynodon dactylon* Pers., Adhartal, 22.12.57, Leg. K. G. Nema.

17. *Taphrina maculans* Butl. on leaves of *Curcuma longa* L., Adhartal, 22.12.57, Leg. K. G. Nema.

BASIDIOMYCETES

18. *Entyloma oryzae* Syd. on leaves of *Oryza sativa* L., Govt. Farm, Adhartal, 8.10.57, Leg. K. G. Nema & G. P. Agarwal.

19. *Sphacelotheca sorghi* (Lk.) Clinton in the ovaries of *Andropogon sorghum* Brot. Govt. Farm, Adhartal, 30.11.58, Leg. K. G. Nema.

20. *Ustilago scitaminea* Syd. in the culms of *Saccharum officinarum* L., Govt. Farm, Adhartal, 20.12.58, Leg. K. G. Nema.

21. *U. cynodontis* P. Henn. in the inflorescence of *Cynodon dactylon* Pers., Adhartal, Decembar, 1958, Leg. G. P. Agarwal & R. Beliram.

22. *U. tritici* (Pers.) Rostrup in ovaries of *Triticum vulgare* Vill., Adhartal, 16.3.58, Leg. K. G. Nema & G. P. Agarwal.

23. *Graphiola applanata* Syd. & Buller on leaves of *Phoenix Sylvestris* Roxb., Wright Town, 15.11.58, Leg. G. P. Agarwal; on leaves of *Phoenix* sp., Adhartal, December, 1957, Leg. K. G. Nema.

24. *Cerotelium fici* (Cast.) Arth. on leaves of *Ficus glomerata* Roxb., near High Court, December 1957, Leg. K. G. Nema.

25. *Puccinia graminis* Pers. on stems and leaves of *Triticum vulgare* Vill., Govt. Farm, Adhartal, February, 1957, Leg. K. G. Nema & G. P. Agarwal.

26. *P. glumarum* (Schm.) Erikss. & Henn. on leaves and culms of *Triticum vulgare* Vill., Govt. Farm, Adhartal, Feb., 1957, Leg. K. G. Nema & G. P. Agarwal.

27. *P. triticina* Eriks. on leaves of *Triticum vulgare* Vill., Govt. Farm, Adhartal, Feb., 1957, Leg. K. G. Nema & G. P. Agarwal.

28. *P. penniseti* Zimm. on leaves of *Pennisetum typhoideum* Rich., Govt. Farm, Adhartal, December, 1958, Leg. G. P. Agarwal, K. G. Nema & R. Beliram.

29. *P. purpurea* Cke. on leaves of *Andropogon sorghum* Brot., Govt. Farm, Adhartal, December, 1958, Leg. K. G. Nema.

30. *Puccinia* sp. on leaves and stems of *Polytoca barbata* Stapf., Pachpedhi, January, 1956, Leg. R. C. Agnihotri.

    It is a new host record for this rust.

31. *Puccinia* sp. on leaves of *Knoxia corymbosa* Willd., College area, October, 1958, Leg. Miss S. Ganguli & Miss V. Bhave. It is a new host, hitherto unknown for *Puccinia* sp.

32. *Melampsora lini* (Pers.) Lev. on leaves and stems of *Linum usitatissimum* L., Govt. Farm, Adhartal, February, 1957, Leg. K. G. Nema.

33. *Melampsora* sp. on leaves and stems of *Euphorbia geniculata* Orteg., College area and Adhartal, February, 1958, Leg. G. P. Agarwal & K. G. Nema. To our knowledge this is the first record of *Melampsora* sp. on *Euphorbia geniculata.*

34. *Uromyces ciceris-arietini* (Grogn.) Jacz. & Boy. on leaves of *Cicer arietinum* L., Adhartal, January, 1957, Leg. K. G. Nema.

FUNGI IMPERFECTI

SPHAEROPSIDALES

35. *Ascochyta sorghi* on leaves of *Andropogon sorghum* Brot., Govt. Farm, Adhartal, December, 1958, Leg. G. P. Agarwal, K. G. Nema & R. Beliram.

36. *Phyllosticta sulata* Chowdhury on leaves of *Carica papaya* L., Napier Town, October, 1958, Leg. Miss S. Ganguli & R. Beliram.

    Three species of *Phyllosticta* have been recorded on *Carica papaya* 1. *P. papayae* Sacc. 2. *P. caricae-papayae* Allesch. 3. *P. sulata* Chowdhury. Local *Phyllosticta*, whose spores measured 3·3–9·8 × 3·3 μ, was nearest to *P. sulata* and therefore assigned to it. *P. sulata* was first described by Chowdhury (1944) from Assam and perhaps has not since been reported from anywhere else in India.

37. *Phyllostictina artocarpina* (Syd. & Butl.) Syd. on leaves of *Artocarpus integrifolia* L., Sadar, College area and Beoharbag, February and October, 1958, Leg. G. P. Agarwal. R. C. Agnihotri & R. Beliram.

    Sydow and Butler (1916) first reported *Phyllosticta artocarpina* from India on leaves of *Artocarpus integrifolia* collected by Chibber from Bombay

Presidency. *Phyllosticta artocarpina* Syd. & Butl. was later on made *Phyllostictina artocarpina* (Syd. & Butl.) Syd. by Petrak and Sydow (1926-27). *Phyllosticta artocarpina* reported by Tandon and Bilgrami (1957) on leaves of *Artocarpus integrifolia* from Allahabad may be *Phyllostictina artocarpina*. *Septoria artocarpi* Cke, on leaves of *Artocarpus integrifolia*, reported by Cooke (1876), has also been suggested to be *Phyllostictina artocarpina* by Butler and Bisby (1931).

38. *P. murrayae* Syd. on leaves of *Murraya koenigii* Spr., near Shahid Smarak, July, 1958, Leg. Miss V. Bhave & Miss S. Ganguli.

The fungus was first described from India by Sydow and Butler (1916) on living leaves of *Murraya koenigii* collected by Butler from Dehradun. Perhaps since then it has not been reported from anywhere else.

Onset of the disease is marked with slight discoloured small areas on the leaves which spread and become light brown with a well defined dark brown zone around the lesion. Spots are commonly globose, less often irregular and measure up to 11 mm. in diameter. Spots often coalesce. Later on the central region becomes dirty white to grey in which pycnidia appear in abundance. With age necrotic centres become papery and brittle and fall off developing 'shot holes'. The rachis, petiole and stem are also attacked. The disease is more marked from July to September and it appears that it is because of heavy rains and high humidity during these months.

Pycnidia are dark brown in colour, subglobose or globose, immersed in host tissue, 40-131 μ in diameter, average 100 μ; conidiophores indistinct, spores hyaline, continuous, oval to spherical, 6·6-13·1 × 3·3-6·6 μ, average 7·9 × 5·2μ.

MELANCONIALES

39. *Colletotrichum falcatum* Went on leaves of *Saccharum officinarum* L., Govt. Farm, Adhartal, December, 1958, Leg. K. G. Nema, G. P. Agarwal & R. Beliram.

40. *C. graminicolum* (Ces.) Wils. on leaves of *Andropogon sorghum* Brot., Govt. Farm, Adhartal, December, 1958, Leg. K. G. Nema, G. P. Agarwal & R. Beliram.

41. *C. lindemuthianum* Br. Cav. on fruits of *Phaseolus vulgaris* L., Sunday Vegetable Market, November, 1957, Leg. G. P. Agarwal.

42. *C. capsici* (Syd.) Butl. & Bisby on ripe fruits of *Capsicum annum* L., Newarganj, 20.12.58, Leg. K. G. Nema.

43. *Gloeosporium musarum* Cke. & Massee on fruits of *Musa paradisiaca* L., Fowara Fruit Market, July, 1957, Leg. G. P. Agarwal.

44. *Pestalotia mangiferae* P. Henn. on leaves of *Mangifera indica* L., College area, September, 1958, Leg. G. P. Agarwal & Miss S. Ganguli.

45. *P. suffocata* Ellis & Ev. on leaves and stems of *Rosa* sp. Beoharbag, October, 1958, Leg. Madhuri Agarwal.

46. *P. palmarum* Cke. on leaves of *Phoenix sylvestris* Roxb., Wright Town, November, 1958, Leg. G. P. Agarwal.

P. palmarum has been recorded on palms but *phoenix sylvestris* is a new host record.

47. *Pestalotiopsis versicolar* (speg.) Steyaert on leaves of *Anogeissus latifolia* Wall, Berhaghat, August, 1958, Leg. S. G. Pandeya; near College, August, 1958, Leg. Miss S. Ganguli.

It is a new host record. Symptoms of the disease and the description of the fungus have been given by Agarwal and Ganguli (1959).

MONILIALES

48. *Alternaria solani* (Ell. & Mart.) Jones & Grout. on leaves of *Solanum tuberosum* L., Govt. Farm, Adhartal, January, 1957, Leg. K. G. Nema; on leaves and fruits of *Lycopersicum esculentum* Mill., Sunday Vegetable Market, 21.12.58, Leg. G. P. Agarwal.

49. *A. zinniae* Pape on leaves of *Ageratum conyzoides* L., Adhartal, December, 1958, Leg. G. P. Agarwal, K. G. Nema & R. Beliram.

Ageratum conyzoides is a new host for *A. zinniae* first described by Agarwal and Bhave (1959).

50. *Cercospora arachidicola* Hori on leaves of *Arachis hypogea* L., Govt. Farm, Adhartal, December, 1958, Leg. G. P. Agarwal, K. G. Nema & R. Beliram.

51. *C. cruenta* Sacc. on leaves of *Phaseolus vulgaris* L. Gramsewak Garden, Adhartal, 6.1.58, Leg. K. G. Nema.

52. *C. indica* Singh on leaves of *Cajanus indicus* Spreng., Govt. Farm, Adhartal, December, 1958, Leg. G. P. Agarwal, K. G. Nema & R. Beliram.

53. *C. personata* (Berk. & Curt.) Ell. & Ev. on leaves of *Arachis hypogea* L., Govt. Farm, Adhartal, December, 1958, Leg. G. P. Agrawal, K. G. Nema & R. Beliram.

54. *C. sesami* Zimm. on leaves of *Sesamum orientale* L., Govt. Farm, Adhartal, December, 1958, Leg. G. P. Agarwal, K. G. Nema & R. Beliram.

55. *C. solanaceae* Sacc. on leaves of *Solanum melongena* L., Govt. Farm, Adhartal, 10.11.57, Leg. K. G. Nema.

56. *C. sorghi* Ell, & Ev. on leaves of *Andropogon sorghum* Brot., Gwarighat, November, 1958, Leg. K. G. Nema.

57. *Cercospora* sp. on leaves of *Cosmos* sp., Beoharbag, September, 1958, Leg. G. P. Agarwal.

58. *Cladosporium* sp. on leaves of *Solanum melongena* L., Adhartal and Beoharbag, November and December, 1953, Leg. K. G. Nema & G. P. Agarwal.

59. *Cladosporium* sp. on leaves of *Shorea robusta* Gaertn., Berhaghat, December, 1957, Leg. N. C. Jain.

Shorea robusta is a new host for *Cladosporium* sp. hitherto unreported.

60. *Fusarium udum* Butl. on roots of *Cajanus indicus* Spreng., Govt. Farm, Adhartal, December, 1958, Leg. G. P. Agarwal & K. G. Nema.

61. *Helminthosporium oryzae* Breda de Haan. on leaves of *Oryza sativa* L., Govt. Farm, Adhartal, Leg. K. G. Nema.

62. *H. turcicum* Pass. on leaves of *Zea mays* L., Govt. Farm. Adhartal, Leg. K. G. Nema; on leaves of *Andropogon sorghum* Brot., Govt. Farm, Adhartal, Leg. G. P. Agarwal & K. G. Nema.

63. H. *rostratum* Drechs. from foot rot of *Triticum vulgare* Vill., Govt. Farm, Adhartal, November, 1956, Leg. G. P. Agarwal & K. G. Nema.

It is a new fungus record for India. Physiolgy of the fungus has been studied by Agarwal (1959).

64. *Piricularia oryzae* Cavara on leaves of *Oryza sativa* L., Govt. Farm, Adhartal, 24.9.57, Leg. K. G. Nema.

MYCELIA STERILIA

65. *Rhizoctonia* sp. from foot rot of *Trioicum vulgare* Vill., Govt. Farm, Adhartal, November, 1956, Leg. G. P. Agarwal & K. G. Nema.

66. *R. solani* Kuehn on tubers of *Solanum tuberosum* L., Adhartal, October, 1957, Leg. K. G. Nema.

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REFERENCES

Agarwal, G. P. 1959. Nitrogen nutrition of *Helminthosporium rostratum* Drechs. *Proc. 46th Indian Sci. Congr.*, pt. III; 312.

Agarwal, G. P. and (Miss) Bhave, V. 1959. *Ageratum conyzoides* L., a new host for *Alternaria zinniae* Pape. *Curr. Sci.*, 28 : 292-293.

Agarwal, G. P. and (Miss) Ganguli, S. 1959. A leaf spot disease of *Anogeissus latifalia* Wall due to *Pestalotiopsis versicolar* (Speg.) Steyaert. *Curr. Sci.* 28 : 295-296.

Butler, E. J. and Bisby, G. R. 1931. The fungi of India, Calcutta. *Sci. Monog. Coun. agric. Res. India*, 1 : xviii : 237 pp.

Chowdhury, S. 1944. A leaf spot of *Carica papaya* L. caused by a new species of *Phyllosticta*, *Indian J. agric. Res.*, 14 : 395-398.

Cooke, M. C. 1876. Some Indian fungi, *Grev.*, IV :114-118.

Cooke, M. C. 1876. Report on diseased leaves of coffee and other plants, Indian Museum Report, 1-7.

Petrak, F. and Sydow, H. 1926-1927. Die Gattungen der Pyrenomyzeten, Sphaeropsideen, und Melanconieen, Fed les Repertorium, Beihefte, XLII, 551 pp., Dahlem.

Sydow, H. & P. and Butler, E. J. 1916. Fungi Indiae orientalis. Pars V. *Ann. Mye.*, XIV : 177-220.

Tandon, R. N. and Bilgrami, K. S. 1957. Leaf spot disease of *Artocarpus heterophyllus* caused by *Phyllosticta artocarpina*, *Proc. Nat. Acad. Sci., India* 27 B: 204-209.

CYTOGENETIC STUDIES IN SOLANUM MELONGENA L. III. HYBRID VIGOUR AND INHERITANCE OF INFLORESCENCE AND FLOWER AND FRUIT COLOUR*

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Vavilov (1928, 1931) has clearly brought out that the centre of origin of crop plant is to be looked for in those areas where the specific and varietal diversity is highest and where largest number of endemic forms are to be found. According to him the centre of origin of *Solanum melongena* L., eggplant or brinjal, is Indo-Burma, region. Sampson (1936, cf. Bhaduri, 1951) considers *Solanum melongena* L., as probably indigenous to Tropical Africa. In India very many forms of *S. melongena* L. are found. Bhaduri (1951) has collected two wild varieties insanum, from Travancore-Cochin, and potangi, from Orissa. Author (1959 a, b) has already dealt about the chromosome morphology and chiasmata frequency of some of the varieties of *S. melongena* L., found in India. The dissimilarity between the large number of cultivated forms grown in different regions of world to day, according to Bhaduri (1951), might well be due to the hybrid vigour and continuous selection by man. It is here that the present studies of hybrid vigour (Kakizaki, 1931; Pal & Singh, 1936) and inheritance of inflorescence and flower and fruit colour have their importance.

Since the eggplant or brinjal is self pollinated only to a small degree, the possible agencies responsible for pollination in nature as worked out by Pal and Singh (1943) are gravity, wind and insects. They however, observed greater percentage of fruit formation in hand pollinated than in natural pollinated ones. The enclosure of flower buds in tissue paper bags, results in failure of pollination due probably to the changes in temperature and humidity around the bud and pendent nature of inflorescence. The simple method of tying petals of the emasculated and pollinated buds by thread (Richaria, personal communication) as outlined below, was employed.

MATERIAL AND METHOD

Seeds of *Solanum melongena* L., varieties *greenlong* (Lucknow) and T. 17 (Delhi) were sown at the Agricultural Botany Experimental Farm of the Allahabad University, Allahabad and cultures GL/selfed/1 (*Purple long*) and T. 17 (*White bunchy*) were selected for the studies.

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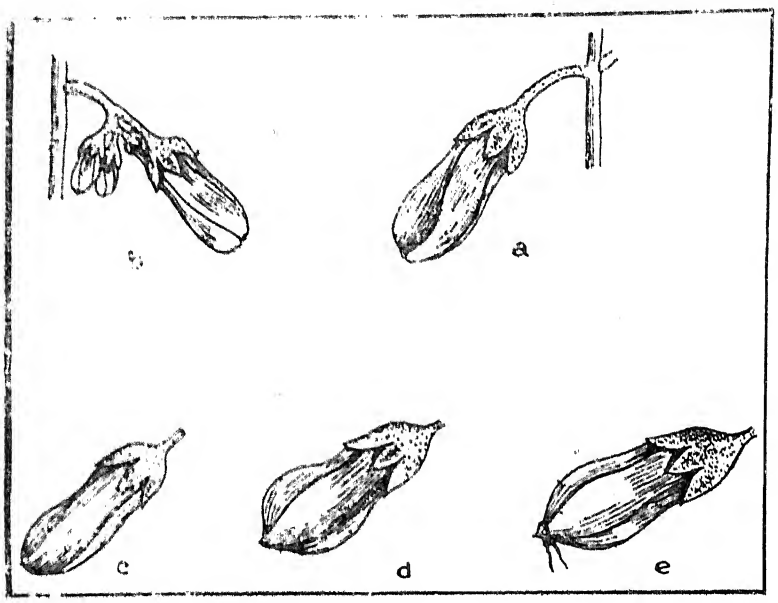
Flower buds with corolla bulged outwards ond upwards (Fig. ld). the stage when a slight pressure at the tip makes it open, were emasculated. This left sufficient space between the style and petals (less in the variety *white bunchy*). The



petals then were brought together in the same order of aestivation and tied at their tip by thread (Fig. 1 c). The tied petals then acted as a naural bag for the emasculated and later on for the pollinated buds. Thus crosses and reciprocalcrosses were made.

OBSERVATION

The above method is handy, less time consuming and efficient with less or no mechanical injury to the buds. After 8—10 days, when the pollination is complete, the whole corolla cap smoothly fell down and ovary enlarges which is the first visible sign of fruit formation. Fruits took 5—6 weeks for ripening when they were harvested and cut open to dry in the sun. Seeds were then separated from the pulp in a trough of water. The F_1 progenies were raised in the next season and characters tabulated below were studied for hybrid vigour.

TABLE I

Showing the hybrid vigour in F_1 of cross between *S. melongena* L. varieties *purple long* and *white bunchy*

Quantitative character	*S. melongena* var. *purple long* (P1)	F_1	*S. melongena* var. *white bunchy* (P2)	F_1-MP	Relative Potence
Height of Plant in c. m.	88·00	69·00	29·00	+ 1·50	+ 0·05
Spread of plant in c. m.	89·00	107·00	32·00	+21·50	+ 6·01
Number of branches	7·00	13·00	8·00	+ 5·50	+11·00
Length of leaf in c. m.	22·60	17·40	13·00	- 0·55	- 0·11
Breadth of leaf in c. m.	13·00	8·60	7·30	- 1·55	- 0·53
Length of petal in c. m.	2·50	2·40	2·50	...	...
Breadth of petal in c. m.	1·60	1·70	1·70	+ 0·05	+ 1·00
Length of anther in m. m.	10·00	10·50	10·00	...	...
Diameter of ovary in m. m.	4·00	4·00	3·00	+ 0·50	+ 1·00
Length of style in m. m.	10·00	12·00	15·00	- 0·50	- 0·20
Length of fruit in c. m.	35·00	20·00	6·00	- 0·50	- 29·00
Breadth of fruit in c. m.	8·00	4·00	7·50	- 0·35	- 15·71
Thickness of skin of fruit in m.m.	3·00	2·00	2·00	- 0·50	- 1·00
Number of fruits per plant	65·00	119·00	126·00	+23·50	+ 1·28
Weight of fruits per plant	120·50	246·00	243·10	+64·20	+ 1·04
Number of seeds per fruit	784·00	406·00	212·00	-92·00	- 0·32
Weight of 100 seeds in gms.	0·650	0·423	0·383	- 0·067	- 0·40
Size of seeds in m. m.	4·00	3·00	3·00	- 0·50	- 1·00

In the above table has been included all the quantitative characters of the F_1 hybrid and its parents and their Relative Potence (Mather, 1949). Deviations of the F_1 means from mid parent values (arithmetical average between parental means) have been used to estimate the preponderance of dominant gene effects, acting in one direction, at loci by which the parental complements differ. The data shown have been obtained by first calculating the difference between the F_1 mean and the mid-parent (F_1-MP) for the cross. The ratio of the deviation of the F_1 from mid-parent to half the parental difference, F_1-MP/½ (P1~P2), is a measure of the relative potence of the gene sets. It is evident from the table that for height and spread of plant, length and breadth of leaf, length of petal, diameter of ovary, length, breadth and thickness of skin, of fruits and number, weight and size of seed, the variety *purple long* parent is larger parent and var. *white bunchy* parent is smaller parent. For number of branches, breadth of petal, length of style, number and weight of fruits

per plant, the variety *white bunchy* is larger parent and var. *purple long* is smaller parent. For plant height and spread, number of branches, breadth of petal, diameter of ovary, number and weight of fruits, the F_1 fall about 0·50, 6·01, 11·00, 1·01, 1·00, 1·28 and 1·04 of the distances from the mid-parent towards the larger parent. For length and breadth of leaf, length of style, length and breadth of fruit, thickness of skin, number, weight and size of seeds, the F_1 fall about 0·11, 0·53. 0·20, 29·00, 15·71, 1·00, 0·32, 0·40 and 1·00 distances respectively from the mid-parent towards the smaller parent. The very fact that hybrid vigour has been obtained in number of branches and number and weight of fruits without getting increased seed weight, reveals the possibility of exploiting hybrid vigour for getting improved strains in brinjals. Kakizaki (1931) while studying the intervarietal crosses in egg plants or bringals found hybrid vigour in seed stem diameter, plant height, earliness and yield of fruits. This may be because he was dealing with more diverse forms of varieties to provide greater disparity between the parents. Pal and Singh (1936) also reported hybrid vigour in brinjal and released a commercial strain.

Inheritance of inflorescence and flower and fruit colour

TABLE II

Showing the nature of inflorescence and flower and fruit colour in F_1 and their parents *S. melongena L.* varieties *purple long* and *white bunchy*.

Character	Purple long Parent	F_1	White bunchy Parent
Inflorescence	Solitary (Fig 1a)	Cluster or Bunchy	Cluster or Bunchy (Fig. 1b)
Flower colour	Purple	Purple	White
Fruit colour	Purple	Purple	White

It will be seen in the above table that F_1 plants have cluster or bunchy inflorescence and purple colour of flowers and fruits. Thus cluster or bunchy inflorescence is dominant over solitary and purple, flower and fruit, is dominant over white.

The segregation of inflorescence character in the F_2 generation has been given in table III.

TABLE III

	Cluster or bunchy Inflorescence	Solitary Inflorescence	Total
Total observed	77	22	99
Total expected on 3 : 1 basis	74·25	24·75	99
Deviation	2·75	2·75	—

It will be seen from the above table that in the F_2 population plants with cluster or bunchy inflorescence are 77 as against 22 of solitary inflorescence. The value of X^2 obtained is 0·40. By refering to X^2 table, for n=1 and p=0·50, the value is 0·455 which is higher than the value of X^2 obtained. The fitness therefore is very good and indicates monofactorial segregation.

The segregation of flower colour in the F_2 generation has been given in table IV.

TABLE IV

Showing the segregation of flower colour in F_2 generation of the cross between *S. melongena L.* varieties *purple long* and *white bunchy*.

	Purple flower	White flower	Total
Total observed	72	27	99
Total expected on 3 : 1 basis	74·25	24·75	99
Deviation	2·25	2·25	–

The F_2 population gave rise to 72 plants with purple flowers and 27 plants with white flowers. The value of X^2 obtained is 0·27. By refering to X^2 table, for n=1 and p=0·50, the value is 0·455 which is higher than the value of X^2 obtained. The fitness is very good and indicates monofactorial segregation.

The segregation of fruit colour in the F_2 generation has been given in table V.

TABLE V

Showing the segregation of fruit colour in the F_2 generation of the cross between *S. melongena L.* varieties *purple long* and *white bunchy*.

	Purple fruit	Green fruit	White fruit	Total
Total observed	55	38	6	99
Total expected on 9 : 6 : 1 basis	55·69	37·12	6·19	99
Deviation	0·69	0·88	0·19	—

It will be seen from the above table the F_2 population gives rise to a third colour green a deviation from the Mendelian segregation. Out of the total population of 99 plants those bearing green coloured fruits are 38 whereas plants bearing purple and white fruits are 55 and 6 respectively. Thus, they appear in the ratio of 55 purple : 38 Green : 6 White i. e. 9·16 : 6·33 : 1. This ratio is nearer to the ratio

9 : 6 : 1 obtained usually due to the interaction between two dominant factors affecting the same character having similar effect when present individually but when both are present they produce double the effect. The middle two classes of phenotypes in 9 : 3 : 3 : 1, become indistinguishable and is termed as 'Polymerism'. The value of X^2 obtained is 0·033. By refering to X^2 table, for n=2 and p=0·50, the value is 1·386 which is much higher than the value obtained. Hence the fitness is very good.

To understand the combination more elaborately the segregation of inflorescence and fruit colour has been given in table VI.

TABLE VI

Showing the segregation of inflorescence and fruit colour together in the F_2 generation of the cross between *S. melongena L.* varieties *purple long* and *white bunchy*.

Inflorescence	Cluster or Bunchy			Solitary			Total
Fruit colour	Purple	Green	White	Purple	Green	White	Total
Total observed	42	30	5	13	8	1	99
Total Expected on (3 : 1 ×9:6:1) 27:18:3:9:6:1 basis	41·7	27·8	4·6	13·9	9·2	1·5	99
Deviation	0·3	2·2	0·4	0·9	1·2	0·5	—

The value of X^2 obtained is 0·89. By refering to X^2 table for n=5, and p=0·50, the value is 4·351. The fitness is very good.

SUMMARY

1. In the intervarietal cross, *Solanum melongena* L. varieties *purple long* and *white bunchy*, hybrid vigour has been obtained in the spread of plant, number of branches and number and weight of fruits.

2. The cluster or bunchy inflorescence of *S. melongena* L. var *white bunchy* parent is dominant over solitary of *S. melongena* L. var. *purple long*. The purple flower of the latter is dominant over white flower of the former. Both show monofactorial segregation in the F_2 generation.

3. The purple fruit of the *S. melongena* L. var. *purple long* is dominant over white fruit of another variety *white bunchy*. The F_2 segregation revealed another fruit colour green. The ratio is 9 purple : 6 green : 1 white. This has been explained as due to interaction between two dominant factors affecting the same character and is termed 'polymerism'.

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REFERENCE

Bhaduri, P. N., 1951. Interrelationship of non-tuberiferous species of *Solanum* with some consideration on the origin of brinjal (*S. melongena* L.). *Ind. Jur. Genet. and Pl. Breed.* 11, 75-82.

Kakizaki, Y. 1931. Hybrid vigour in eggplants and its practical utilization. *Genetics* 16, 1-25.

Mather, K., 1949. Biometrical Genetics. *Dover publications, New York.*

Pal, B. P. and Singh H. B., 1943. Floral characters and fruit formation in the eggplant. *Ind. Jour. Genet and Pl. Breed.*, 3, 45-58.

Pal, B. P. and Singh, H. B. 1946. Studies in hybrid vigour, II. Notes on the manifestation of hybrid vigour in the brinjal and bitter gourd. *Ind. Jour. Genet. and Pl. Breed.*, 6, 19-33.

Rai, U. K., 1959a. Cytogenetic studies in *Solanum melongena* L., I. Chromosome morphology *Caryologia* (in press).

Rai. U. K., 1959b. Cytogenetic studies in *Solanum melongena* L., II. chiasmata frequency, *Cytologia* (in press).

Vavilov, N. I., 1928. Geographical centres of our Cultivated plants. Proc. *5th International Genet. Congress, N. Y.*, 342-369.

Vavilov, N. I., 1931. Mexico and Central America as the principal centre of origin of cultivated plants of the New World. *Bull. Appl. Bot. Genet. Pl. Breed* 26.

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